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1916, 1930, 1931, 1934, and 1936 editions of BOWDITCH

(Tables in back of book)

(1916)

Page	Table No.	Title
531	2	Traverse table, degrees
---	-	Conversion of departure into difference of longitude (not in these editions - refer to 1938 edition, Table 4, page 106)
621	3	Meridional parts
634	5B	Distance of an object by two bearings, degrees
---	-	Time, speed, and distance tables (not in these editions - refer to 1938 edition, Table 13, page 140)
755	42	Logarithms of numbers
772	44	Logarithms of trigonometric functions, degrees
817	45	Logarithmic and natural haversines

No. 9

American Practical Navigato

An Epitome of Navigation and Nautical Astronomy

ORIGINALLY BY
NATHANIEL BOWDITCH, LL. D.

PUBLISHED BY THE
UNITED STATES HYDROGRAPHIC OFFICE
UNDER THE AUTHORITY OF
THE SECRETARY OF THE NAVY

UNIV. OF CALIF.

WASHINGTON
GOVERNMENT PRINTING OFFICE
1916

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STATUTES OF AUTHORIZATION.

There shall be a Hydrographic Office attached to the Bureau of Navigation in the Navy Department, for the improvement of the means for navigating safely the vessels of the Navy and of the mercantile marine, by providing, under the authority of the Secretary of the Navy, accurate and cheap nautical charts, sailing directions, navigators, and manuals of instructions for the use of all vessels of the United States, and for the benefit and use of navigators generally. (R. S. 431.)

The Secretary of the Navy is authorized to cause to be prepared, at the Hydrographic Office attached to the Bureau of Navigation in the Navy Department, maps, charts, and nautical books relating to and required in navigation, and to publish and furnish them to navigators at the cost of printing and paper, and to purchase the plates and copyrights of such existing maps, charts, navigators, sailing directions, and instructions, as he may consider necessary, and when he may deem it expedient to do so, and under such regulations and instructions as he may prescribe. (R. S. 432.)

W 211

PART I.

TEXT AND APPENDICES.

359861

NOTE ON REPRINT OF 1916.—This reprint is the same as the 1914 edition, except that the examples worked out in the text have been brought up to date to accord with the form of the American Nautical Almanac as now published.

CONTENTS OF PART I.

Page.

Abbreviations 7

Chapter I. Definitions relating to Navigation 9

II. Instruments and Accessories in Navigation 11

III. The Compass Error 36

IV. Piloting 56

V. The Sailings 72

VI. Dead Reckoning 84

VII. Definitions relating to Nautical Astronomy 87

VIII. Instruments employed in Nautical Astronomy 91

IX. Time and the Nautical Almanac 102

X. Correction of Observed Altitudes 115

XI. The Chronometer Error 121

XII. Latitude 126

XIII. Longitude 140

XIV. Azimuth 144

XV. The Sumner Line 150

XVI. The Practice of Navigation at Sea 169

XVII. Marine Surveying 189

XVIII. Winds 206

XIX. Cyclonic Storms 212

XX. Tides 225

XXI. Ocean Currents 232

XXII. Ice and its Movements in the North Atlantic Ocean 238

Appendix I. Extracts from the American Ephemeris and Nautical Almanac for the year 1916 which have reference to examples for that year given in this work 248

II. A collection of Forms for working Dead Reckoning and various Astronomical Sights, with notes explaining their application under all circumstances 254

III. Explanation of certain Rules and Principles of Mathematics of use in the Solution of Problems in Navigation 266

IV. Maritime Positions and Tidal Data 278

Index 358

ABBREVIATIONS USED IN THIS WORK.

Alt. (or *h*)	Altitude.
a. m	Ante meridian.
Amp	Amplitude.
App	Apparent.
App. t	Apparent time.
Ast	Astronomical.
Ast. t	Astronomical time.
Aug	Augmentation.
Az. (or Z)	Azimuth.
C	Course.
C. C	Chronometer correction.
C—W	Chronometer *minus* watch.
Chro. t	Chronometer time.
Co. L	Co. latitude.
Col	Column.
Corr	Correction.
Cos	Cosine.
Cosec	Cosecant.
Cot	Cotangent.
d (or Dec.)	Declination.
D (or D.Lo)	Difference longitude.
Dep	Departure.
Dev	Deviation.
Diff	Difference.
Dist	Distance.
DL	Difference latitude.
D. R	Dead reckoning.
E., Ely	East, easterly.
Elap. t	Elapsed time.
Eq. t	Equation of time.
F	Longitude factor.
f	Latitude factor.
G. (or Gr.)	Greenwich.
G. A. T	Greenwich apparent time.
G. M. T	Greenwich mean time.
G. S. T	Greenwich sidereal time.
h	Altitude.
H	Meridian altitude.
H. A. (or *t*)	Hour angle.
Hav	Haversine.
H. D	Hourly difference.
H. P. (or Hor. par.)	Horizontal parallax.
Hr-s	Hour-s.
H. W	High water.
I. C	Index correction.
L. (or Lat.)	Latitude.
L. A. T	Local apparent time.
L. M. T	Local mean time.

L. S. T	Local sidereal time.
Lo. (or Long.)	Longitude.
Log	Logarithm.
Lun. Int	Lunitidal interval.
L. W	Low water.
λ	Longitude.
m	Meridional difference.
Merid	Meridian or noon.
Mag	Magnetic.
M. D	Minute's difference.
Mid	Middle.
Mid. L	Middle latitude.
M. T	Mean time.
nat	Natural.
N., Nly	North, northerly.
N. A. (or Naut. Alm.)	Nautical Almanac.
Np	Neap.
Obs	Observation.
p (or P. D.)	Polar distance.
p. c	Per compass.
P. D. (or *p*)	Polar distance.
P. L. (or Prop. Log.)	Proportional logarithm.
p. m	Post meridian.
p. & r.	Parallax and refraction.
Par	Parallax.
R. A	Right ascension.
R. A. M. S	Right ascension mean sun.
Red	Reduction.
Ref	Refraction.
S., Sly	South, southerly.
S. D	Semidiameter.
Sec	Secant.
Sid	Sidereal.
Sin	Sine.
Spg	Spring.
t	Hour angle.
T	Time.
Tab	Table.
Tan	Tangent.
Tr. (or Trans.)	Transit.
Var	Variation.
Vert	Vertex or vertical.
W., Wly	West, westerly.
W. T	Watch time.
z	Zenith distance.
Z	Azimuth.
θ	Auxiliary angle.
λ	Difference longitude in time.

SYMBOLS.

⊙	The Sun.
☾	The Moon.
✱	A Star or Planet.
⊙̄ ☾̄	Alt. upper limb.
⊙̲ ☾̲	Alt. lower limb.
⏀ ⊙	Azimuthal angle.

°	Degrees.
′	Minutes of Arc.
″	Seconds of Arc.
ʰ	Hours.
ᵐ	Minutes of Time.
ˢ	Seconds of Time.

GREEK LETTERS.

Α α	Alpha.
Β β	Beta.
Γ γ	Gamma.
Δ δ	Delta.
Ε ε	Epsilon.
Ζ ζ	Zeta.
Η η	Eta.
Θ θ	Theta.
Ι ι	Iota.
Κ κ	Kappa.
Λ λ	Lambda.
Μ μ	Mu.

Ν ν	Nu.
Ξ ξ	Xi.
Ο ο	Omicron.
Π π	Pi.
Ρ ρ	Rho.
Σ σ (ς)	Sigma.
Τ τ	Tau.
Υ υ	Upsilon.
Φ φ	Phi.
Χ χ	Chi.
Ψ ψ	Psi.
Ω ω	Omega.

CHAPTER I.

DEFINITIONS RELATING TO NAVIGATION.

---

1. That science, generally termed *Navigation,* which affords the knowledge necessary to conduct a ship from point to point upon the earth, enabling the mariner to determine, with a sufficient degree of accuracy, the position of his vessel at any time, is properly divided into two branches: *Navigation* and *Nautical Astronomy.*

2. *Navigation,* in its limited sense, is that branch which treats of the determination of the position of the ship by reference to the earth, or to objects thereon. It comprises (*a*) *Piloting,* in which the position is ascertained from visible objects upon the earth, or from soundings of the depth of the sea, and (*b*) *Dead Reckoning,* in which the position at any moment is deduced from the direction and amount of a vessel's progress from a known point of departure.

3. *Nautical Astronomy* is that branch of the science which treats of the determination of the vessel's place by the aid of celestial objects—the sun, moon, planets, or stars.

4. Navigation and Nautical Astronomy have been respectively termed *Geo-Navigation* and *Celo-Navigation,* to indicate the processes upon which they depend.

5. As the method of piloting can not be employed excepting near land or in moderate depths of water, the navigator at sea must fix his position either *by dead reckoning* or *by observation of celestial objects;* the latter method is more exact, but as it is not always available, the former must often be depended upon.

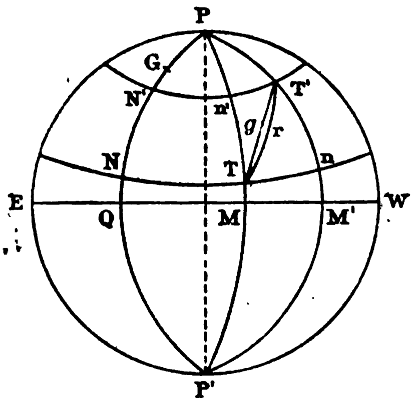

FIG. 1.

6. THE EARTH.—The Earth is an oblate spheroid, being a nearly spherical body slightly flattened at the poles; its longer or equatorial axis measures about 7,927 statute miles, and its shorter axis, around which it rotates, about 7,900 statute miles.

The Earth (assumed for purposes of illustration to be a sphere) is represented in figure 1.

The *Axis of Rotation,* usually spoken of simply as the *Axis,* is PP′.

The *Poles* are the points, P and P′, in which the axis intersects the surface, and are designated, respectively, as the *North Pole* and the *South Pole.*

The *Equator* is the great circle EQMW, formed by the intersection with the earth's surface of a plane perpendicular to the axis; the equator is equidistant from the poles, every point upon it being 90° from each pole.

Meridians are the great circles PQP′, PMP′, PM′P′, formed by the intersection with the earth's surface of planes secondary to the equator (that is, passing through its poles and therefore perpendicular to its plane).

Parallels of Latitude are small circles NT*n*, N′*n*′T′, formed by the intersection with the earth's surface of planes passed parallel to the equator.

The *Latitude* of a place on the surface of the earth is the arc of the meridian intercepted between the equator and that place. Latitude is reckoned *North* and *South,* from the equator as an origin, through 90° to the poles; thus, the latitude of the point T is MT, north, and of the point T′, M′T′, north. The *Difference of Latitude* between any two places is the arc of a meridian intercepted between their parallels of latitude, and is called *North* or *South,* according to direction; thus, the difference of latitude between T and T′ is T*n*′ or T′*n*, north from T or south from T′.

The *Longitude* of a place on the surface of the earth is the arc of the equator intercepted between its meridian and that of some place from which the longitude is reckoned. Longitude is measured *East* or *West* through 180° from the meridian of a designated place, such meridian being termed the *Prime Meridian;* the prime meridian used by most nations, including the United States, is that of Greenwich, England. If, in the figure, the prime meridian be PGQP′, then the longitude of the point T is QM, east, and of T′, QM′, east. The *Difference of Longitude* between any two places is the arc of the equator intercepted between their meridians, and is called *East* or *West*, according to direction; thus, the difference of longitude between T and T′ is MM′, east from M or west from M′. The *Departure* is the linear distance, measured on a parallel of latitude, between two meridians; unlike the various quantities previously defined, departure is reckoned in miles; the departure between two meridians varies with the parallel of latitude upon which it is measured; thus, the departure between the meridians of T and T′ is the number of miles corresponding to the distance T*n* in the latitude of T, or to *n*′T′ in the latitude of T′.

The curved line which joins any two places on the earth's surface, cutting all the meridians at the same angle, is called the *Rhumb Line*, *Loxodromic Curve*, or *Equiangular Spiral*. In the figure this line is represented by T*r*T′. The constant angle which this line makes with the meridians is called the *Course;* and the length of the line between any two places is called the *Distance* between those places.

The unit of linear measure employed by navigators is the *Nautical* or *Sea Mile*, or *Knot*. This unit is defined in the United States of America as being 6,080.27 feet in length and equal to one-sixtieth part of a degree of a great circle of a sphere whose surface is equal in area to the area of the surface of the earth.

The nautical mile is not exactly the same in all countries, but, from the navigator's standpoint, the various lengths adopted do not differ materially.

Since, upon the ocean, latitude has been capable of easier and more accurate determination than longitude, it might naturally be expected that there exists an intimate fixed relation between the nautical mile and the minute of latitude (or the length of that portion of a meridian which subtends at the earth's center the angular measure of one minute); but on account of the fact that the earth is not a perfect sphere, a fixed relation does not exist, and the arc of a meridian that subtends an angle of 1′ at the center of the earth varies slightly in length from the Equator to the poles, being 6,045.95 feet at the Equator and 6,107.85 feet at the poles. Its average length is 1,852.201 meters, or 6,076.82 feet. Accordingly in France, Germany, and Austria the nautical mile is 1,852 meters, 2,025.41 yards, or 6,076.23 feet.

For purposes of navigation the nautical mile is assumed to be equal to a minute of latitude in all parts of the world; and, hence, when a vessel changes her position to the north or south by 1 nautical mile, it may always be considered that the latitude has changed 1′. Owing to the fact that the meridians converge toward the poles, the difference of longitude produced by a change of position of 1 mile to the east or west will vary with the latitude; thus, a departure of 1 mile will equal a difference of longitude of 1′ at the Equator, but of more than 1′ at any higher latitude, being in fact equal to 1′.1 of longitude in latitude 30° and to 2′ of longitude in latitude 60°.

In England the nautical mile, corresponding to the *Admiralty knot*, is regarded as having a length of 6,080 feet.

The statute mile of 5,280 feet, which is employed in land measurements, is commonly used in navigating river and lake vessels. This is notably the case on the Great Lakes of America, but with the recognition of the advantages to be gained by the practice of nautical astronomy in the navigation of these vessels, the use of the nautical mile is extending.

The *Great Circle Track* or *Course* between any two places is the route between those places along the circumference of the great circle which joins them. In the figure this line is represented by T*g*T′. From the properties of a great circle (which is a circle upon the earth's surface formed by the intersection of a plane passed through its center) the distance between two points measured on a great circle track is shorter than the distance upon any other line which joins them. Except when the two points are on the same meridian or when both lie upon the equator, the great circle track will always differ from the rhumb line, and the great circle track will intersect each intervening meridian at a different angle.

CHAPTER II.

INSTRUMENTS AND ACCESSORIES IN NAVIGATION.

DIVIDERS OR COMPASSES.

7. This instrument consists of two legs movable about a joint, so that the points at the extremities of the legs may be set at any required distance from each other. It is used to take and transfer distances and to describe arcs and circles. When used for the former purpose it is termed *dividers*, and the extremities of both legs are metal points; when used for describing arcs or circles, it is called a *compass*, and one of the metal points is replaced by a pencil or pen.

PARALLEL RULERS.

8. *Parallel rulers* are used for drawing lines parallel to each other in any direction, and are particularly useful in transferring the rhumb-line on the chart to the nearest compass-rose to ascertain the course, or to lay off bearings and courses.

PROTRACTOR.

9. This is an instrument used for the measurement of angles upon paper; there is a wide variation in the material, size, and shape in which it may be made. (For a description of the *Three Armed Protractor*, see art. 428, Chap. XVII.)

THE CHIP LOG.

10. This instrument, for measuring the rate of sailing, consists of three parts; viz, the *log-chip*, the *log-line*, and the *log-glass*. A light substance thrown from the ship ceases to partake of the motion of the vessel as soon as it strikes the water, and will be left behind on the surface; after a certain interval, if the distance of the ship from this stationary object be measured, the approximate rate of sailing will be given. The *log-chip* is the float, the *log-line* is the measure of the distance, and the *log-glass* defines the interval of time.

The *log-chip* is a thin wooden quadrant of about 5 inches radius, loaded with lead on the circular edge sufficiently to make it float upright in the water. There is a hole in each corner of the log-chip, and the log-line is knotted in the one at the apex; at about 8 inches from the end there is seized a wooden socket; a piece of line of proper length, being knotted in the other holes, has seized into its bight a wooden peg to fit snugly into the socket before the log-chip is thrown; as soon as the line is checked this peg pulls out, thus allowing the log-chip to be hauled in with the least resistance.

The *log-line* is about 150 fathoms in length, one end made fast to the log-chip, the other to a reel upon which it is wound. At a distance of from 15 to 20 fathoms from the log-chip a permanent mark of red bunting about 6 inches long is placed to allow sufficient *stray line* for the log-chip to clear the vessel's eddy or wake. The rest of the line is divided into lengths of 47 feet 3 inches called *knots*, by pieces of fish-line thrust through the strands, with one, two, three, etc., knots, according to the number from stray-line mark; each knot is further subdivided into five equal lengths of two-tenths of a knot each, marked by pieces of white rag.

The length of a knot depends upon the number of seconds which the log-glass measures; the length of each knot must bear the same ratio to the nautical mile ($\frac{1}{60}$ of a degree of a great circle of the earth, or 6,080 feet) that the time of the glass does to an hour.

In the United States Navy all log-lines are marked for log-glasses of 28 seconds, for which the proportion is:

$$3600 : 6080 = 28^s : x,$$

x being the length of the knot.

Hence,

$$x = 47^{ft}.29, \text{ or } 47^{ft}\ 3^{in}.$$

The speed of the ship is estimated in knots and tenths of a knot.

The *log-glass* is a sand glass of the same shape and construction as the old hour-glass. Two glasses are used, one of 28 seconds and one of 14 seconds; the latter is employed when the ship is going at a high rate of speed, the number of knots indicated on a line marked for a 28-second glass being doubled to obtain the true rate of speed.

11. The log in all its parts should be frequently examined and adjusted; the peg must be found to fit sufficiently tight to keep the log-chip upright; the log-line shrinks and stretches and should often be verified; the log-glass should be compared with a watch. One end of the glass is stopped with a cork, by removing which the sand may be dried or its quantity corrected.

12. A *ground log* consists of an ordinary log-line, with a lead attached instead of a chip; in shoal water, where there are no well-defined objects available for fixing the position of the vessel and the course and speed are influenced by a tidal or other current, this log is sometimes used, its advantage being that the lead marks a stationary point to which motion may be referred, whereas the chip would drift with the stream. The speed, which is marked in the usual manner, is the speed over the ground, and the trend of the line gives the course actually made good by the vessel.

THE PATENT LOG.

13. This is a mechanical contrivance for registering the distance actually run by a vessel through the water. There are various types of patent logs, but for the most part they act upon the same principle, consisting of a registering device, a fly or rotator, and a log or towline; the rotator is a small spindle with a number of blades extending radially in such manner as to form a spiral, and, when drawn through the water in the direction of its axis, rotates about that axis after the manner of a screw propeller; the rotator is towed from the vessel by means of a log or towline from 30 to 100 fathoms in length, made fast at its apex, the line being of special make, so that the turns of the rotator are transmitted through it to the worm shaft of the register, to which the inboard end of the line is attached; the registering device is so constructed as to show upon a dial face the distance run, according to the number of turns of its worm shaft due to the motion of the rotator; the register is carried at some convenient point on the vessel's quarter; it is frequently found expedient to rig it out upon a small boom, so that the rotator will be towed clear of the wake.

14. Though not a perfect instrument, the patent log affords a means of determining the vessel's speed through the water. It will usually be found that the indications of the log are in error by a constant percentage, and the amount of this error should be determined by careful experiment and applied to all readings.

Various causes may operate to produce inaccuracy of working in the patent log, such as the bending of the blades of the rotator by accidental blows, fouling of the rotator by seaweed or refuse from the ship, or mechanical wear of parts of the register. The length of the towline has much to do with the working of the log, and by varying the length the indications of the instrument may sometimes be adjusted when the percentage of error is small; it is particularly important that the line shall not be too short. The readings of the patent log can not be depended upon for accuracy at low speeds, when the rotator does not tow horizontally, nor in a head or a following sea, when the effect depends upon the wave motion as well as upon the speed of the vessel.

15. Electrical registers for patent logs are in use, the distance recorded by the mechanical register being communicated electrically to some point of the vessel which is most convenient for the purposes of those charged with the navigation.

16. A number of instruments based upon different physical principles have been devised for recording the speed of a vessel through the water and have been used with varying degrees of success. Of these the hydraulic speed indicator, known as the Nicholson Ship Log, affords an instance.

17. The revolutions of the screw propeller afford in a steamer the most valuable means of determining a vessel's speed through the water. The number of revolutions per knot must be carefully determined for the vessel by experiment under varying conditions of speed, draft, and foulness of bottom.

THE LEAD.

18. This device, for ascertaining the depth of water, consists essentially of a suitably marked line, having a lead attached to one of its ends. It is an invaluable aid to the navigator in shallow water, particularly in thick or foggy weather, and is often of service when the vessel is out of sight of land.

Two leads are used for soundings—the *hand-lead*, weighing from 7 to 14 pounds, with a line marked to about 25 fathoms, and the *deep-sea lead*, weighing from 30 to 100 pounds, the line being 100 fathoms or upward in length.

Lines are generally marked as follows:

2 fathoms from the lead, with 2 strips of leather.
3 fathoms from the lead, with 3 strips of leather.
5 fathoms from the lead, with a white rag.
7 fathoms from the lead, with a red rag.
10 fathoms from the lead, with leather having a hole in it.
13 fathoms from the lead, same as at 3 fathoms.
15 fathoms from the lead, same as at 5 fathoms.
17 fathoms from the lead, same as at 7 fathoms.
20 fathoms from the lead, with 2 knots.
25 fathoms from the lead, with 1 knot.
30 fathoms from the lead, with 3 knots.
35 fathoms from the lead, with 1 knot.
40 fathoms from the lead, with 4 knots.
And so on.

Fathoms which correspond with the depths marked are called *marks;* the intermediate fathoms are called *deeps;* the only fractions of a fathom used are a half and a quarter.

A practice sometimes followed is to mark the hand-lead line in feet around the critical depths of the vessel by which it is to be used.

Lead lines should be measured frequently while wet and the correctness of the marking verified. The distance from the leadsman's hand to the water's edge should be ascertained in order that proper allowance may be made therefor in taking soundings at night.

19. The deep-sea lead may be *armed* by filling with tallow a hole hollowed out in its lower end, by which means a sample of the bottom is brought up.

THE SOUNDING MACHINE.

20. This machine possesses advantages over the deep-sea lead, for which it is a substitute, in that soundings may be obtained at great depths and with rapidity and accuracy without stopping the ship. It consists essentially of a stand holding a reel upon which is wound the sounding wire, and which is controlled by a suitable brake. Crank handles are provided for reeling in the wire after the sounding has been taken. Attached to the outer end of the wire is the lead, which has a cavity at its lower end for the reception of the tallow for arming. Above the lead is a cylindrical case containing the depth-registering mechanism; various devices are in use for this purpose, all depending, however, upon the increasing pressure of the water with increasing depths.

21. In the *Lord Kelvin machine* a slender glass tube is used, sealed at one end and open at the other, and coated inside with a chemical substance which changes color upon contact with sea water; this tube is placed, closed end up, in the metal cylinder; as it sinks the water rises in the tube, the contained air being compressed with a force dependent upon the depth. The limit of discoloration is marked by a clearly defined line, and the depth of the sounding corresponding to this line is read off from a scale. Tubes that have been used in comparatively shallow water may be used again where the water is known to be deeper.

22. A tube whose inner surface is *ground* has been substituted for the chemical-coated tube, ground glass, when wet, showing clear. The advantage of these tubes is that they may be used an indefinite number of times if thoroughly dried. To facilitate drying, a rubber cap is fitted to the upper end, which, when removed, admits of a circulation of the air through the tube.

23. As a substitute for the glass tubes a mechanical *depth recorder* contained in a suitable case has been used. In this device the pressure of the water acts upon a piston against the tension of a spring. A scale with an index pointer records the depth reached. The index pointer must be set at zero before each sounding.

24. Since the action of the sounding machine, when glass tubes are used, depends upon the compression of the air, the barometric pressure of the atmosphere must be taken into account when accurate results are required. The correction consists in *increasing* the indicated depth by a fractional amount according to the following table:

Bar. reading.	Increase.
"	
29.75	One-fortieth.
30.00	One-thirtieth.
30.50	One-twentieth.
30.75	One-fifteenth.

THE MARINER'S COMPASS.

25. The *Mariner's Compass* is an instrument consisting either of a single magnet, or, more usually, of a group of magnets, which, being attached to a graduated circle pivoted at the center and allowed to swing freely in a horizontal plane, has a tendency, when not affected by disturbing magnetic features within the ship, to lie with its magnetic axis in the plane of the earth's magnetic meridian, thus affording a means of determining the azimuth, or horizontal angular distance from that meridian, of the ship's course and of all visible objects, terrestrial or celestial.

26. The circular card of the compass is divided on its periphery into 360°, frequently numbered from 0° at North and South to 90° at East and West; also into thirty-two divisions of 11¼° each, called *points*, the latter being further divided into *half-points* and *quarter-points;* still finer subdivisions, *eighth-points*, are sometimes used, though not indicated on the card. A system of numbering the degrees from 0° to 360°, always increasing toward the right, is shown in figure 2. This system is in use in the United States Navy and by the mariners of some foreign nations, and its general adoption would carry with it certain undoubted advantages.

27. *Boxing the Compass* is the process of naming the points in their order, and is one of the first things to be learned by the young mariner. The four principal points are called *cardinal points* and are named North, South, East, and West; each differs in direction from the adjacent one by 90°, or 8 points. Midway between the cardinal points, at an angular distance of 45°, or 4 points, are the *inter-cardinal* points, named according to their position Northeast, Southeast, etc. Midway between each cardinal and inter-cardinal point, at an angular distance of 22½°, or 2 points, is a point whose name is made up of a combination of that of the cardinal with that of the inter-cardinal point: North-Northeast, East-Northeast, East-Southeast, etc. At an angular distance of 1 point, or 11¼°, from each cardinal and inter-cardinal point (and therefore midway between it and the 22½°-division last described), is a point which bears the name of that cardinal or inter-cardinal point joined by the word *by* to that of the cardinal point in the direction of which it lies: North by East, Northeast by North, Northeast by East, etc.

In boxing by fractional points, it is evident that each division may be referred to either of the whole points to which it is adjacent; for instance, NE. by N. ½ N. and NNE. ½ E. would describe the same division. It is the custom in the United States Navy to box *from* North and South *toward* East and West, excepting that divisions adjacent to a cardinal or inter-cardinal point are always referred to that point; as N. ½ E., N. by E. ½ E., NNE. ½ E., NE. ½ N., etc. Some mariners, however, make it a practice to box *from* each cardinal and inter-cardinal point *toward* a 22½°-point (NNE., ENE., etc.); as N. ½ E., N. by E. ½ E., NE. by N. ½ N., NE. ½ N., etc.

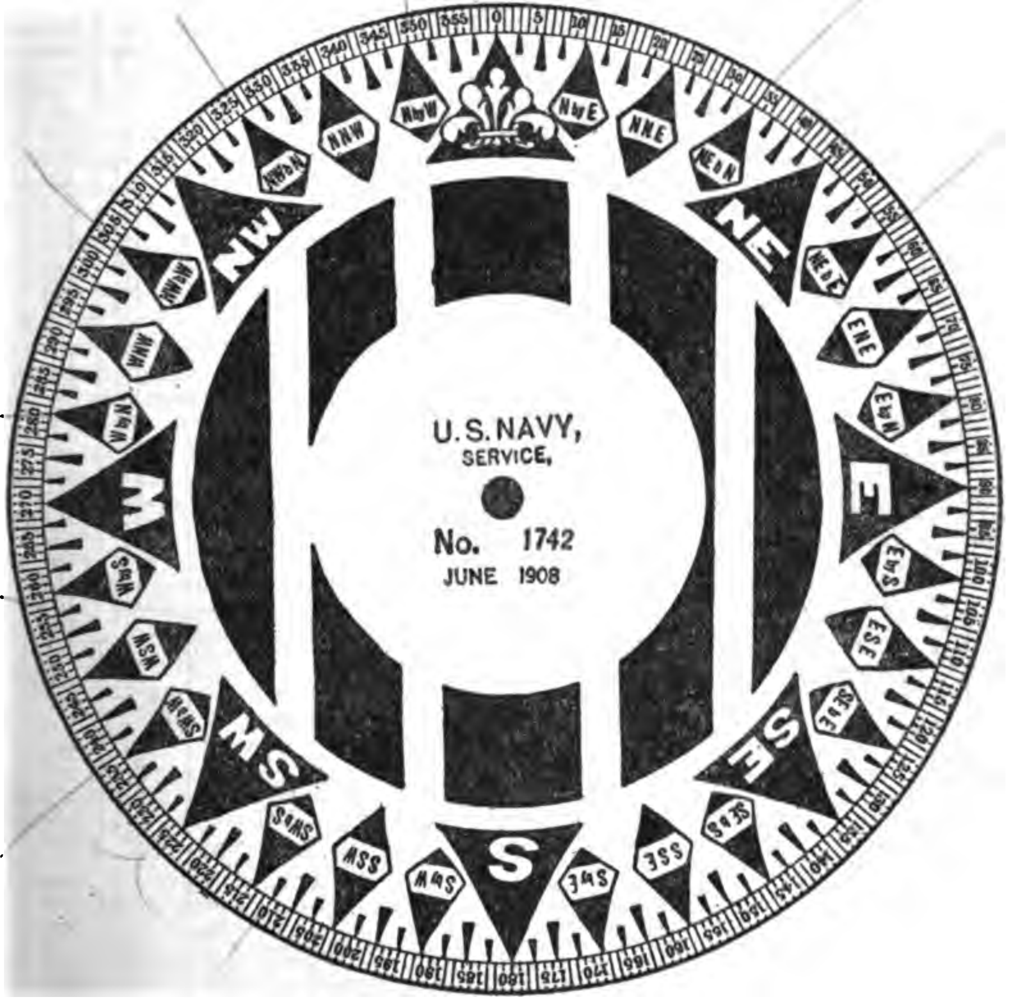

FIG. 2.

The names of the whole points, together with fractional points (according to the nomenclature of the United States Navy), are given in the following table, which shows also the degrees, minutes, and seconds from North or South to which each division corresponds:

	Points.	Angular measure.		Points.	Angular measure.
NORTH TO EAST.			EAST TO SOUTH.		
North:		° ′ ″	East	8	90 00 00
N. ¼ E	¼	2 48 45	E. ¼ S	8¼	92 48 45
N. ½ E	½	5 37 30	E. ½ S	8½	95 57 30
N. ¾ E	¾	8 26 15	E. ¾ S	8¾	98 26 15
N. by E	1	11 15 00	E. by S	9	101 15 00
N. by E. ¼ E	1¼	14 03 45	ESE. ¾ E	9¼	104 03 45
N. by E. ½ E	1½	16 52 30	ESE. ½ E	9½	106 52 30
N. by E. ¾ E	1¾	19 41 15	ESE. ¼ E	9¾	109 41 15
NNE	2	22 30 00	ESE	10	112 30 00
NNE. ¼ E	2¼	25 18 45	SE. by E. ¾ E	10¼	115 18 45
NNE. ½ E	2½	28 07 30	SE. by E. ½ E	10½	118 07 30
NNE. ¾ E	2¾	30 56 15	SE. by E. ¼ E	10¾	120 56 15
NE. by N	3	33 45 00	SE. by E	11	123 45 00
NE. ¾ N	3¼	36 33 45	SE. ¾ E	11¼	126 33 45
NE. ½ N	3½	39 22 30	SE. ½ E	11½	129 22 30
NE. ¼ N	3¾	42 11 15	SE. ¼ E	11¾	132 11 15
NE	4	45 00 00	SE	12	135 00 00
NE. ¼ E	4¼	47 48 45	SE. ¼ S	12¼	137 48 45
NE. ½ E	4½	50 37 30	SE. ½ S	12½	140 37 30
NE. ¾ E	4¾	53 26 15	SE. ¾ S	12¾	143 26 15
NE. by E	5	56 15 00	SE. by S	13	146 15 00
NE. by E. ¼ E	5¼	59 03 45	SSE. ¾ E	13¼	149 03 45
NE. by E. ½ E	5½	61 52 30	SSE. ½ E	13½	151 52 30
NE. by E. ¾ E	5¾	64 41 15	SSE. ¼ E	13¾	154 41 15
ENE	6	67 30 00	SSE	14	157 30 00
ENE. ¼ E	6¼	70 18 45	S. by E. ¾ E	14¼	160 18 45
ENE. ½ E	6½	73 07 30	S. by E. ½ E	14½	163 07 30
ENE. ¾ E	6¾	75 56 15	S. by E. ¼ E	14¾	165 56 15
E. by N	7	78 45 00	S. by E	15	168 45 00
E. ¾ N	7¼	81 33 45	S. ¾ E	15¼	171 33 45
E. ½ N	7½	84 22 30	S. ½ E	15½	174 22 30
E. ¼ N	7¾	87 11 15	S. ¼ E	15¾	177 11 15
SOUTH TO WEST.			WEST TO NORTH.		
South	16	180 00 00	West	24	270 00 00
S. ¼ W	16¼	182 48 45	W. ¼ N	24¼	272 48 45
S. ½ W	16½	185 37 30	W. ½ N	24½	275 37 30
S. ¾ W	16¾	188 26 15	W. ¾ N	24¾	278 26 15
S. by W	17	191 15 00	W. by N	25	281 15 00
S. by W. ¼ W	17¼	194 03 45	WNW. ¾ W	25¼	284 03 45
S. by W. ½ W	17½	196 52 30	WNW. ½ W	25½	286 52 30
S. by W. ¾ W	17¾	199 41 15	WNW. ¼ W	25¾	289 41 15
SSW	18	202 30 00	WNW	26	292 30 00
SSW. ¼ W	18¼	205 18 45	NW. by W. ¾ W	26¼	295 18 45
SSW. ½ W	18½	208 07 30	NW. by W. ½ W	26½	298 07 30
SSW. ¾ W	18¾	210 56 15	NW. by W. ¼ W	26¾	300 56 15
SW. by S	19	213 45 00	NW. by W	27	303 45 00
SW. ¾ S	19¼	216 33 45	NW. ¾ W	27¼	306 33 45
SW. ½ S	19½	219 22 30	NW. ½ W	27½	309 22 30
SW. ¼ S	19¾	222 11 15	NW. ¼ W	27¾	311 11 15
SW	20	225 00 00	NW	28	315 00 00
SW. ¼ W	20¼	227 48 45	NW. ¼ N	28¼	317 48 45
SW. ½ W	20½	230 37 30	NW. ½ N	28½	320 37 30
SW. ¾ W	20¾	233 26 15	NW. ¾ N	28¾	323 26 15
SW. by W	21	236 15 00	NW. by N	29	326 15 00
SW. by W. ¼ W	21¼	239 03 45	NNW. ¾ W	29¼	329 03 45
SW. by W. ½ W	21½	241 52 30	NNW. ½ W	29½	331 52 30
SW. by W. ¾ W	21¾	244 41 15	NNW. ¼ W	29¾	334 41 15
WSW	22	247 30 00	NNW	30	337 30 00
WSW. ¼ W	22¼	250 18 45	N. by W. ¾ W	30¼	340 18 45
WSW. ½ W	22½	253 07 30	N. by W. ½ W	30½	343 07 30
WSW. ¾ W	22¾	255 56 15	N. by W. ¼ W	30¾	345 56 15
W. by S	23	258 45 00	N. by W	31	348 45 00
W. ¾ S	23¼	261 33 45	N. ¾ W	31¼	351 33 45
W. ½ S	23½	264 22 30	N. ½ W	31½	354 22 30
W. ¼ S	23¾	267 11 15	N. ¼ W	31¾	357 11 15
			North	32	360 00 00

28. The compass card is mounted in a bowl which is carried in *gimbals*, thus enabling the card to retain a horizontal position while the ship is pitching and rolling. A vertical black line called the *lubber's line* is marked on the inner surface of the bowl, and the compass is so mounted that a line joining its pivot with the lubber's line is parallel to the keel line of the vessel; thus the lubber's line always indicates the compass direction of the ship's head.

29. According to the purpose which it is designed to fulfill, a compass is designated as a *Standard, Steering, Check*, or *Boat Compass*. On United States naval vessels additional compasses are designated as follows: Maneuvering, battle, auxiliary battle, top, and conning-tower compasses.

30. There are two types of magnetic compass in use, the *liquid* or *wet* and the *dry;* in the former the bowl is filled with liquid, the card being thus partially buoyed with consequent increased ease of working on the pivot, and the liquid further serving to decrease the vibrations of the card when deflected by reason of the motion of the vessel or other cause. On account of its advantages the liquid compass is used in the United States Navy.

31. THE NAVY SERVICE 7½-INCH LIQUID COMPASS.—This consists of a skeleton card 7½ inches in diameter, made of tinned brass, resting on a pivot in liquid, with provisions for two pairs of magnets symmetrically placed.

The magnet system of the card consists of four cylindrical bundles of steel wires; these wires are laid side by side and magnetized as a bundle between the poles of a powerful electro-magnet. They are afterwards placed in a cylindrical case, sealed, and secured to the card. Steel wires made up into a bundle were adopted because they are more homogeneous, can be more perfectly tempered, and for the same weight give greater magnetic power than a solid steel bar.

Two of the magnets are placed parallel to the north and south diameter of the card, and on the chords of 15° (nearly) of a circle passing through their extremities. These magnets penetrate the air vessel, to which they are soldered, and are further secured to the bottom of the ring of the card. The other two magnets of the system are placed parallel to the longer magnets on the chords of 45° (nearly) of a circle passing through their extremities and are secured to the bottom of the ring of the card.

The card is of a curved annular type, the outer ring being convex on the upper and inner side, and is graduated to read to one-quarter point, a card circle being adjusted to its outer edge and divided to half degrees, with legible figures at each 3°, for use in reading bearings by an azimuth circle or in laying the course to degrees.

The card is provided with a concentric spheroidal air vessel, to buoy its own weight and that of the magnets, allowing a pressure of between 60 and 90 grains on the pivot at 60° F.; the weight of the card in air is 3,060 grains. The air vessel has within it a hollow cone, open at its lower end, and provided with the pivot bearing or cap, containing a sapphire, which rests upon the pivot and thus supports the card; the cap is provided with adjusting screws for accurately centering the card. The pivot is fastened to the center of the bottom of the bowl by a flanged plate and screws. Through this plate and the bottom of the bowl are two small holes which communicate with the expansion chamber and admit of a circulation of the liquid between it and the bowl. The pivot is of gun metal with an iridium cap.

The card is mounted in a bowl of cast bronze, the glass cover of which is closely packed with rubber, preventing the evaporation or leakage of the liquid, which entirely fills the bowl. This liquid is composed of 45 per cent pure alcohol and 55 per cent distilled water, and remains liquid below −10° F.

The lubber's line is a fine line drawn on an enameled plate on the inside of the bowl, the inner surface of the latter being covered with an insoluble white paint.

Beneath the bowl is a metallic self-adjusting expansion chamber of elastic metal, by means of which the bowl is kept constantly full without the show of bubbles or the development of undue pressure caused by the change in volume of the liquid due to changes of temperature.

The rim of the compass bowl is made rigid and its outer edge turned strictly to gauge to receive the azimuth circle.

32. THE DRY COMPASS.—The *Lord Kelvin Compass*, which may be regarded as the standard for the dry type, consists of a strong paper card with the central parts cut away and its outer edge stiffened by a thin aluminum ring. The pivot is fitted with an iridium point, upon which rests a small light aluminum boss fitted with a sapphire bearing. Radiating from this boss are 32 silk threads whose outer ends are made fast to the inner edge of the compass card; these threads sustain the weight of the suspended card, and as they possess some elasticity, tend to decrease the shocks due to motion.

Eight small steel wire needles, 3¼ to 2 inches long, are secured normally to two parallel silk threads, and are slung from the aluminum rim of the card by other silk threads which pass through eyes in the ends of the outer pair of needles. The needles are below the radial threads, thus keeping the center of gravity low.

33. The Gyro Compass.—This compass, which has recently been developed, consists essentially of a rapidly spinning rotor, usually driven by a three-phase alternating current of electricity, at a rate varying according to the type, from 8,000 to 21,000 revolutions per minute, and so suspended that it automatically places its axis approximately in the direction of the geographical meridian and permits of the reading of the heading of the ship, unaffected by any magnetic influence, from a graduated compass card like that in use on magnetic compasses. From the "master compass," which may be located in a compartment below, electrical connections are made to "repeating compasses" on the bridge, in the conning tower, or in the steering-engine room, so that the ship's true heading may be transmitted to any desired part of the vessel.

The action of the gyro compass, affected as it is by the earth's rotation under it, conforms to Foucault's general law that "a spinning body tends to swing around so as to place its axis parallel to the axis of any impressed forces, and so that its direction of rotation is the same as that of the impressed forces." Small corrections, depending upon the latitude, course, and speed, can be readily computed for application to the gyro compass readings either mechanically or by reference to tables.

34. The Azimuth Circle.—This is a necessary fitting for all compasses employed for taking bearings—that is, noting the directions—of either celestial or terrestrial objects. The instrument varies widely in its different forms; the essential features which all share consist in (*a*) a pair of sight vanes, or equivalent device, at the extremities of the diameter of a circle that revolves concentrically with the compass bowl, the line of sight thus always passing through the vertical axis of the compass; and (*b*) a system, usually of mirrors and prisms, by which the point of the compass card cut by the vertical plane through the line of sight—in other words, the compass direction—is brought into the field of view of the person making the observation. In some circles, for observing azimuths of the sun advantage is taken of the brightness of that body to reflect a pencil of light upon the card in such a manner as to indicate the bearing; such an azimuth circle is used in the United States Navy.

The azimuth circles should be tested occasionally for accuracy. This can best be done by mounting a standard compass on a tripod in a nonmagnetic spot on shore, in a locality where the variation has been accurately determined. The observed compass bearing of the sun should, of course, be the same as the computed magnetic bearing at any instant, the difference between the two, if any, being equal to the error of the compass or, what is more likely, the error of the azimuth circle. Any doubt in the matter may be removed by the use of two or more compasses. It will be frequently found that the error of the azimuth circle varies with the sun's altitude; this is due to the fact that the axis of the mirror is not normal to the plane passing through the sun, the 5-sided prism, and the center of the mirror.

35. Binnacles.—Compasses are mounted for use in stands known as *Binnacles*, of which there are two principal types—the *Compensating* and the *Noncompensating Binnacle*, so designated according as they are or are not equipped with appliances by which the deviation of the compass, or error in its indications due to disturbing magnetic features within the ship may be compensated.

Binnacles may be of wood or of some nonmagnetic metal; all contain a compass chamber within which the compass is suspended in its gimbal ring, the knife edges upon which it is suspended resting in V-shaped bearings; an appropriate method is supplied for centering the compass. A hood is provided for the protection of the compass and for lighting it at night. Binnacles must be rigidly secured to the deck of the vessel in such position that the lubber's line of the compass gives true indications of the direction of the ship's head.

The position of the various binnacles on shipboard and the height at which they carry the compass must be chosen with regard to the purpose which the compass is to serve, having in mind the magnetic conditions of the ship.

Compensating binnacles contain the appliances for carrying the various correctors used in the compensation of the deviation of the compass. These consist of (*a*) a system of permanent magnets for semicircular deviation, placed in a magnetic chamber lying immediately beneath the compass chamber, so arranged as to permit variation in the height and number of the magnets employed; (*b*) a pair of arms projecting horizontally from the compass chamber and supporting masses of soft iron for quadrantal deviation; (*c*) a central tube in the vertical axis of the binnacle for a permanent magnet used to correct the heeling error; and (*d*) an attachment, sometimes fitted, for securing a vertical soft-iron rod, or "Flinders bar," used in certain cases for correction of a part of the semicircular deviation. An explanation of the various terms here used, together with the method of compensating the compass, will be given in Chapter III.

THE PELORUS.

36. This instrument consists of a circular flat metallic ring, mounted in gimbals, upon a vertical standard at some point on board ship affording a clear view for taking bearings. The inner edge of this ring is engraved in degrees—the 360° and the 180° marks indicating a fore-and-aft line parallel to the keel of the ship. Within this ring a ground-glass dial is pivoted concentrically. This ground-glass dial has painted upon it a compass rose divided into points and subdivisions and into 360°. This dial is capable of revolution, but may be clamped to the outside ring. Pivoted concentrically with the flat ring and the glass dial is a horizontal bar carrying at both of its extremes a sight vane, or, mounted upon the bar and parallel to it, a telescope containing cross wires. This sight-vane bar can be clamped in any position independently of the ground-glass dial, which can be moved freely beneath it. An indicator showing the direction the sight-vane bar points can be read upon the compass card on the glass dial.

The instrument is used for taking bearings of distant objects, and, at times, may be more convenient than the standard compass for that purpose on account of the better view commanded by its position, as well as because it may be made to eliminate compass errors from observed bearings, thus reducing the bearings observed to magnetic or true bearings. If the glass dial be revolved until the degree of demarcation which is coincident with the right-ahead marking on the flat ring is the same as that which points to the lubber's line of the standard compass, then all directions indicated by the glass will be parallel to the corresponding directions of the standard compass, and all bearings taken by the pelorus will be identical with those taken by the compass (leaving out of the question the difference due to the distance which separates them). If it is known that the ship's compass has a certain error due to deviation of the compass and if the glass dial be set to allow for this deviation, then all bearings read from the pelorus will be magnetic. If the dial be set allowing for both deviation and variation of the compass, then all bearings read will be true. It should be noted, however, that the bearings taken by pelorus will be accurate only when the ship is on her exact course by standard compass. For this reason it is usual to take a bearing by pelorus, at the same time noting the heading by standard compass, and clamping the sight vane; then, moving the glass dial until the direction opposite the dead-ahead mark is the same as that noted by the standard compass, the bearing observed (corrected for the variation and for the deviation of the heading at the instant of observation) will be the true bearing.

The pelorus described above is of the most modern type and is fitted for illuminating the glass dial from below in order to facilitate night work.

Peloruses whose dials are controlled by a master gyroscopic compass of course indicate at once the true bearing of the object observed.

When fitted with a telescope the pelorus may be used to take the azimuth of stars.

The standard compass is usually located in the ship in the central fore-and-aft line which is established from the builders' marks placed in that vicinity. The standard compass being located, all peloruses may be oriented from it by any one of the following methods:

(*a*) By making the azimuth of a celestial body, taken by the pelorus, coincide with the simultaneous azimuth of the same body taken by the standard compass.

(*b*) By a similar process with distant objects; and the parallax may be entirely eliminated in an apparently near object, in view of the moderate distance that usually separates the two instruments on board ship.

(*c*) By reciprocal bearings between the correct instrument and the instrument to be established; it is evident that if the lubber lines of the two instruments are both in the direction of the keel line, the bearing of the sight vane of each from the other (one being reversed) should coincide.

(*d*) By computing the angle subtended at the pelorus by the fore-and-aft line through the pelorus and the line drawn through the pelorus to the jack staff, and setting the pelorus at this angle and sighting on the jack staff.

THE CHART.

37. A nautical *chart* is a miniature representation upon a plane surface, in accordance with a definite system of projection or development, of a portion of the navigable waters of the world. It generally includes the outline of the adjacent land, together with the surface forms and artificial features that are useful as aids to navigation, and sets forth the depths of water, especially in the near approaches to the land, by soundings that are fixed in position by accurate determinations. Except in charts of harbors or other localities so limited that the curvature of the earth is inappreciable on the scale of construction, a nautical chart is always framed over with a network of parallels of latitude and meridians of longitude in relation to which the features to be depicted on the chart are located and drawn; and the mathematical relation between the meridians and parallels of the chart and those of the terrestrial sphere determines the method of measurement that is to be employed on the chart and the special uses to which it is adapted.

38. There are three principal systems of projection in use: (*a*) the *Mercator*, (*b*) the *polyconic*, and (*c*) the *gnomonic;* of these the Mercator is by far the most generally used for purposes of navigation proper, while the polyconic and the gnomonic charts are employed for nautical purposes in a more restricted manner, as for plotting surveys or for facilitating great circle sailing.

39. THE MERCATOR PROJECTION.—The *Mercator Projection*, so called, may be said to result from the development, upon a plane surface, of a cylinder which is tangent to the earth at the equator, the various points of the earth's surface having been projected upon the cylinder in such manner that the *loxodromic curve* or *rhumb line* (art. 6, Chap. I) appears as a right line preserving the same angle of bearing with respect to the intersected meridians as does the ship's track.

In order to realize this condition, the line of tangency, which coincides with the earth's equator, being the circumference of a right section of the cylinder, will appear as a right line on the development; while the series of elements of the cylinder corresponding to the projected terrestrial meridians will appear as equidistant right lines, parallel to each other and perpendicular to the equator of the chart, maintaining the same relative positions and the same distance apart on that equator as the meridians have on the terrestrial spheroid. The series of terrestrial parallels will also appear as a system of right lines parallel to each other and to the equator, and will so intersect the meridians as to form a system of rectangles whose altitudes, for successive intervals of latitude, must be variable, increasing from the equator in such manner that the angles made by the rhumb line with the meridian on the chart may maintain the required equality with the corresponding angles on the spheroid.

40. MERIDIONAL PARTS.—At the equator a degree of longitude is equal to a degree of latitude, but in receding from the equator and approaching the pole, while the degrees of latitude remain always of the same length (save for a slight change due to the fact that the earth is not a perfect sphere), the degrees of longitude become less and less.

Since, in the Mercator projection, the degrees of longitude are made to appear everywhere of the same length, it becomes necessary, in order to preserve the proportion that exists at different parts of the earth's surface between degrees of latitude and degrees of longitude, that the former be increased from their natural lengths, and such increase must become greater and greater the higher the latitude.

The length of the meridian, as thus increased, between the equator and any given latitude, expressed in minutes at the equator as a unit, constitutes the number of *Meridional Parts* corresponding to that latitude. The Table of Meridional Parts or Increased Latitudes (Table 3), computed for every minute of latitude between 0° and 80°, affords facilities for constructing charts on the Mercator projection and for solving problems in Mercator sailing.

41. To Construct a Mercator Chart.[a]—If the chart for which a projection is to be made includes the equator, the values to be measured off are given directly by Table 3. If the equator does not come upon the chart, then the parallels of latitude to be laid down should be referred to a *principal parallel*, preferably the lowest parallel to be drawn on the chart. The distance of any other parallel of latitude from the principal parallel is then the difference of the values for the two taken from Table 3.

The values so found may either be measured off, without previous numerical conversion, by means of a diagonal scale constructed on the chart, or they may be laid down on the chart by means of any properly divided scale of yards, meters, feet, or miles, after having been reduced to the scale of proportions adopted for the chart.

If, for example, it be required to construct a chart on a scale of one-quarter of an inch to five minutes of arc on the equator, a diagonal scale may first be constructed, on which ten meridional parts, or ten minutes of arc on the equator, have a length of half an inch.

It may often be desirable to adapt the scale to a certain allotment of paper. In this case, the lowest and the highest parallels of latitude may first be drawn on the sheet on which the transfer is to be made. The distance between these parallels may then be measured, and the number of meridional parts between them ascertained. Dividing the distance by this number will then give the length of one meridional part, or the quantity by which *all* the meridional parts taken from Table 3 must be multiplied. This quantity will represent the *scale of the chart*. If it occurs that the limits of longitude are a governing consideration, the case may be similarly treated.

Example: Let a projection be required for a chart of 14° extent in longitude between the parallels of latitude 20° 30′ and 30° 25′, and let the space allowable on the paper between these parallels measure 10 inches.

Entering the column in Table 3 headed 20°, and running down to the line marked 30′ in the side column, will be found 1248.9; then, entering the column 30°, and running down to the line 25′, will be found 1905.5. The difference, or $1905.5 - 1248.9 = 656.6$, is the value of the meridional arc between these latitudes, for which 1′ of arc of the equator is taken as the unit. On the intended projection, therefore, 1′ of arc of longitude will measure $\frac{10^{\text{in.}}}{656.6} = 0.0152$ inch, which will be the scale of the chart. For the sake of brevity call it 0.015. By this quantity all the values derived from Table 3 will have to be multiplied before laying them down on the projection, if they are to be measured on a diagonal scale of one inch.

Draw in the center of the sheet a straight line, and assume it to be the middle meridian of the chart. Construct very carefully on this line a perpendicular near the lower border of the sheet, and assume this perpendicular to be the parallel of latitude 20° 30′; this will be the southern inner neat line of the chart. From the intersection of the lines lay off on the parallel, on each side of the middle meridian, seven degrees of longitude, or distances each equal to $0.015 \times 60 \times 7 = 6.3$ inches; and through the points thus obtained draw lines parallel to the middle meridian, and these will be the eastern and western neat lines of the chart.

In order to construct the parallel of latitude for 21° 00′, find, in Table 3, the meridional parts for 21° 00′, which are 1280.8. Subtracting from this number the number for 20° 30′, and multiplying the difference by 0.015, we obtain 0.478 inch, which is the distance on the chart between 20° 30′ and 21° 00′. On the meridians lay off distances equal to 0.478 inch, and through the three points thus obtained draw a straight line, which will be the parallel of 21° 00′.

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[a] This construction for the purpose of plotting lines of position in ordinary navigation will often be unnecessary if use is made of the Position Plotting Sheets published by the Hydrographic Office.

Proceed in the same manner to lay down all the parallels answering to full degrees of latitude; the distances will be respectively:

$$0^{\text{in}}.015\times(1344.9-1248.9)=1.440 \text{ inches.}$$
$$0^{\text{in}}.015\times(1409.5-1248.9)=2.409 \text{ inches.}$$
$$0^{\text{in}}.105\times(1474.5-1248.9)=3.384 \text{ inches, etc.}$$

Thus will be shown the parallels of latitude 22° 00′, 23° 00′, 24° 00′, etc. Finally, lay down in the same way the parallel of latitude 30° 25′, which will be the northern inner neat line of the chart.

A degree of longitude will measure on this chart $0^{\text{in}}.015\times60=0^{\text{in}}.9$. Lay off, therefore, on the lowest parallel of latitude drawn on the chart, on a middle one, and on the highest parallel, measuring from the middle meridian toward each side, the distances of $0^{\text{in}}.9$, $1^{\text{in}}.8$, $2^{\text{in}}.7$, $3^{\text{in}}.6$, etc., in order to determine the points where meridians answering to full degrees cross the parallels drawn on the chart. Through the points thus found draw the meridians. Draw then the outer neat lines of the chart at a convenient distance outside of the inner neat lines, and extend to them the meridians and parallels. Between the inner and outer neat lines of the chart subdivide the degrees of latitude and longitude as minutely as the scale of the chart will permit, the subdivisions of the degrees of longitude being found by dividing the degrees into equal parts, and the subdivisions of the degrees of latitude being accurately found in the same manner as the full degrees of latitude previously described, though it will generally be found sufficiently exact to make even subdivisions of the degrees, as in the case of the longitude.

The subdivisions between the two eastern as well as those between the two western neat lines will serve for measuring or estimating terrestrial distances. Distances between points bearing North and South of each other may be ascertained by referring them to the subdivisions between the same parallels. Distances represented by lines at an angle to the meridians (loxodromic lines) may be measured by taking between the dividers a small number of the subdivisions near the middle latitude of the line to be measured, and stepping them off on that line. If, for instance, the terrestrial length of a line running at an angle to the meridians between the parallels of latitude of 24° 00′ and 29° 00′ be required, the distance shown on the neat space between 26° 15′ and 26° 45′ (=30 nautical miles) may be taken between the dividers and stepped off on that line.

42. Coast lines and other positions are plotted on the chart by their latitude and longitude. A chart may be transferred from any other projection to that of Mercator by drawing a system of corresponding parallels of latitude and meridians over both charts so close to each other as to form minute squares, and then the lines and characters contained in each square of the map to be transferred may be copied by the eye in the corresponding squares of the Mercator projection.

Since the unit of measure, the mile or minute of latitude, has a different value in every latitude, there is an appearance of distortion in a Mercator chart that covers any large extent of surface; for instance, an island near the pole will be represented as being much larger than one of the same size near the equator, due to the different scale used to preserve the character of the projection.

43. THE POLYCONIC PROJECTION.—This projection is based upon the development of the earth's surface on a series of cones, a different one for each parallel of latitude, each one having the parallel as its base, and its vertex in the point where a tangent to the earth at that latitude intersects the earth's axis. The degrees of latitude and longitude on this chart are projected in their true length, and the general distortion of the figure is less than in any other method of projection, the relative magnitudes being closely preserved.

A straight line on the polyconic chart represents a near approach to a great circle, making a slightly different angle with each successive meridian as the meridians converge toward the pole and are theoretically curved lines; but it is only on charts of large extent that this curvature is apparent; the parallels are also curved, this fact being apparent to the eye upon all excepting the largest scale charts.

This method of projection is especially adapted to the plotting of surveys; it is also employed to some extent in the charts of the United States Coast and Geodetic Survey.

44. Gnomonic Projection.—This is based upon a system in which the plane of projection is tangent to the earth at some given point; the eye of the spectator is situated at the center of the sphere, where, being at once in the plane of every great circle, it will see all such circles projected as straight lines where the visual rays passing through them intersect the plane of projection. In a gnomonic chart, the straight line between any two points represents the arc of a great circle, and is therefore the shortest line between those points.

Excepting in the polar regions, for which latitudes the Mercator projection can not be constructed, the gnomonic charts are not used for general navigating purposes. Their greatest application is to afford a ready means of finding the course and distance at any time in great circle sailing, the method of doing which will be explained in Chapter V.

45. Meridians Adopted in the Construction of Charts.—The nautical charts published by the United States are based upon the meridian of Greenwich, and this meridian is also the origin of longitudes in use on the nautical charts published by the Governments of Argentina, Austria, Belgium, Brazil, Chile, Denmark, France, Germany, Great Britain, Holland (for all charts published at Batavia and for some published at The Hague), Italy, Japan, Norway, Russia, and Sweden.

In addition to the meridian of Greenwich, the meridian of Pulkowa Observatory, at St. Petersburg, in longitude 30° 19′ 40″ east of Greenwich, is sometimes referred to in the Russian charts. At one time the Royal Observatory at Naples, in longitude 14° 15′ 26″ east of Greenwich, was referred to in the Italian charts, and the observatory at Christiania, in longitude 10° 43′ 23″ east of Greenwich, was referred to in the Norwegian charts.

The French charts are based both upon the meridian of Greenwich and of the Observatory at Paris, which has been determined to be in longitude 2° 20′ 14.6″ east of Greenwich. The longitudes of a few Dutch charts published at The Hague are reckoned from the meridian of the west tower of the cathedral at Amsterdam, which is in longitude 4° 53′ 01.5″ east of Greenwich. Portuguese charts refer to the meridian of the observatory of Lisbon Castle, which is 9° 07′ 54.86″ west of Greenwich, and to the meridian of Greenwich. In Spain the meridian of San Fernando Observatory, at Cadiz, which is in longitude 6° 12′ 20″ west of Greenwich, and also the meridian of Greenwich, are used.

46. Quality of Bottom.—The following table shows the qualities of the bottom, as expressed on charts of various nations:

United States.	English.	French.	Italian.	Spanish.	German.
Clay............C.	Clay............cl.	Argile..........A.	Argila.........arg.	Arcillo or Barro.arc.	Lehm............L.
Coral...........Co.	Coral..........crl.	Corail.........Cor.	Corállo.........crl.	Coral............cl.	Korallen........Kor.
Gravel..........G.	Gravel..........g.	Gravier........Gr.	Rena or Ghiaja.gh.	Cascájo..........Co.	Kies.............k.
Mud............M.	Mud............m.	Vase............V.	Fango...........f.	Fango or Luno...F.	Schlamm.......Schl.
Rocky.........rky.	Rock...........rk.	Roche..........R.	Roccia...........r.	Piedra or Roca. P. or r.	Felsig...........Fls.
Sand............S.	Sand............s.	Sable............S.	Sábbia or Aréna..s.	Arena............A.	Sand............Sd.
Shells..........Sh.	Shells..........sh.	Coquille......Coq.	Conchiglia.......c.	Conchuela.......ca.	Muscheln.........M.
Stone...........St.	Stones..........st.	Pierre...........P.	Pietre...........p.	Piedra...........P.	Stein............St.
Weed.........Wd.	Weed.........wd.	Herb...........H.	Alga...........alg.	Alga.............A.	Gras...........Grs.
Fine...........fne.	Fine.............f.	Fin............fin.	Fino...............	Fina..............f.	Fein..............f.
Coarse.........crs.	Coarse...........c.	Gros.............g.	Grosso.............	Gruesa...........g.	Grob...........gb.
Stiff............stf.	Stiff............stf.	Dure............d.	Tenace............	Tenaz............	Schlick..........sk.
Soft............sft.	Soft............sft.	Molle...........m.	Molle.............	Blando........bdo.	Weich.........Wch.
Black..........bk.	Black.........blk.	Noire...........n.	Nero..............	Negro...........n.	Schwarz.......schw.
Red............rd.	Red............rd.	Rouge...........r.	Rosse.............	Rojo.............r.	Roth..............r.
Yellow.........yl.	Yellow..........y.	Jaune...........j.	Giallo.............	Amarillo.......am.	Gelb..............g.
Gray...........gy.					

47. Measures of Depth.—The following table shows the units of measure employed in expressing the soundings in the more modern nautical charts of foreign nations together with their equivalents in the units of measure used in the charts published by the United States:

Nationality of chart.	Unit of soundings.	Equivalent in United States units.		Nationality of chart.	Unit of soundings.	Equivalent in United States units.	
		Feet.	Fathoms.			Feet.	Fathoms.
Argentine	Metro	3. 281	0. 547	Japanese	Fathom	6. 000	1. 000
Austrian	Metro	3. 281	0. 547	Norwegian	Metre	3. 281	0. 547
	or faden	6. 223	1. 037		or favn	6. 176	1. 029
Belgian	Metre	3. 281	0. 547	Portuguese	Metro	3. 281	0. 547
Chilean	Metro	3. 281	0. 547	Russian	Sajene	6. 000	1. 000
Danish	favn	6. 176	1. 029	Spanish	Metro	3. 281	0. 547
Dutch	vadem	5. 905	0. 984		or braza	5. 492	0. 914
	or metre	3. 281	0. 547	Swedish	Metre	3. 281	0. 547
French	Metre	3. 281	0. 547		or famn	5. 844	0. 974
German	do	3. 281	0. 547	British	Fathom	6. 000	1. 000
Italian	Metro	3. 281	0. 547				

THE BAROMETER.

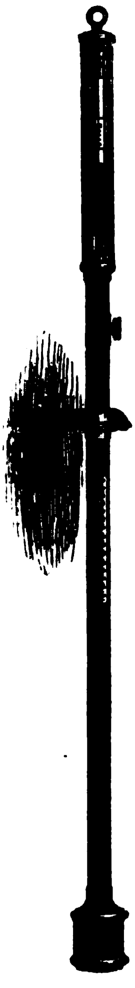

Fig. 3.

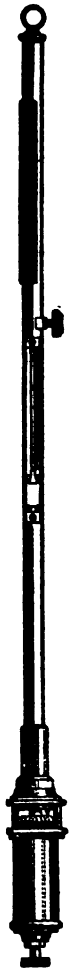

Fig. 4.

48. The *barometer* is an instrument for measuring the pressure of the atmosphere, and is of great service to the mariner in affording a knowledge of existing meteorological conditions and of the probable changes therein. There are two classes of barometer—*mercurial* and *aneroid.*

49. The Mercurial Barometer.—This instrument, invented by Torricelli in 1643, indicates the pressure of the atmosphere by the height of a column of mercury.

If a glass tube of uniform internal diameter somewhat more than 30 inches in length and closed at one end be completely filled with pure mercury, and then placed, open end down, in a cup of mercury (the open end having been temporarily sealed to retain the liquid during the process of inverting), it will be found that the mercury in the tube will fall until the top of the column is about 30 inches above the level of that which is in the cup, leaving in the upper part of the tube a vacuum. Since the weight of the column of mercury thus left standing in the tube is equal to the pressure by which it is held in position—namely, that of the atmospheric air—it follows that the height of the column is subject to variation upon variation of that pressure; hence the mercury falls as the pressure of the atmosphere decreases and rises as that pressure increases. The mean pressure of the atmosphere is equal to nearly 15 pounds to the square inch; the mean height of the barometer is about 30 inches.

50. In the practical construction of the barometer the glass tube which contains the mercury is encased in a brass tube, the latter terminating at the top in a ring to be used for suspension, and at the bottom in a flange, to which the several parts forming the cistern are attached. The upper part of the brass tube is partially cut away to expose the mercurial column for observation; abreast this opening is fitted a scale for measuring the height, and along the scale travels a *vernier* for exact reading; the motion of the vernier is controlled by a rack and pinion, the latter having a milled head accessible to the observer, by which the adjustment is made. In the middle of the brass tube is fixed a thermometer, the bulb of which is covered from the outside but open toward the mercury, and which, being nearly in contact with the glass tube, indicates the temperature of the mercury and not that of the external air; the central position of the column is selected in order that the mean temperature may be obtained—a matter of importance, as the temperature of the mercurial column must be taken into account in every accurate application of its reading.

51. In the arrangement of further details mercurial barometers are divided into two classes, according as they are to be used, as *Standards* (fig. 4) on shore, or as *Sea Barometers* (fig. 3) on shipboard.

In the Standard Barometer the scale and vernier are so graduated as to enable an observer to read the height of the mercurial column to the nearest 0.002 inch, while in the Sea Barometer the reading can not be made closer than 0.01 inch.

The instruments also differ in the method of obtaining the true height of the mercurial column at varying levels of the liquid in the cistern. It is evident that as the mercury in the tube rises, upon increase of atmospheric pressure, the mercury in the cistern must fall; and, conversely, when the mercurial column falls the amount of fluid in the cistern will thereby be increased and a rise of level will occur. As the height of the mercurial column is required above the existing level in the cistern, some means must be adopted to obtain the true height under varying conditions. In the Standard Barometer the mercury of the cistern is contained in a leather bag, against the bottom of which presses the point of a vertical screw, the milled head of the screw projecting from the bottom of the instrument and thus placing it under control of the observer. By this means the surface of the mercury in the cistern (which is visible through a glass casing) may be raised or lowered until it exactly coincides with that level which is chosen as the zero of the scale, and which is indicated by an ivory pointer in plain view.

In the Sea Barometer there is no provision for adjusting the level of the cistern to a fixed point, but compensation for the variable level is made in the scale graduations; a division representing an inch on the scale is a certain fraction short of the true inch, proper allowance being thus made for the rise in level which occurs with a fall of the column, and for the reverse condition.

Further modification is made in the Sea Barometer to adapt it to the special use for which intended. The tube toward its lower end is much contracted to prevent the oscillation of the mercurial column known as "pumping," which arises from the motion of the ship; and just below this point is a trap to arrest any small bubbles of air from finding their way upward. The instrument aboard ship is suspended in a revolving center ring, in gimbals, supported on a horizontal brass arm which is screwed to the bulkhead; a vertical position is thus maintained by the tube at all times.

52. The *vernier* is an attachment for facilitating the exact reading of the scale of the barometer, and is also applied to many other instruments of precision, as, for example, the sextant and theodolite. It consists of a metal scale similar in general construction to that of the instrument to which it is fitted, and arranged to move alongside of and in contact with the main scale.

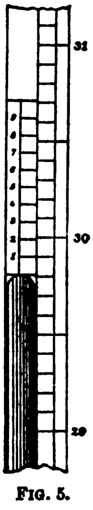

FIG. 5.

The general principle of the vernier requires that its scale shall have a total length exactly equal to some whole number of divisions of the scale of the instrument and that this length shall be subdivided into a number of parts equal to 1 more or 1 less than the number of divisions of the instrument scale which are covered; thus, if a space of 9 divisions of the main scale be designated as the length of the vernier, the vernier scale would be divided into either 8 or 10 parts.

Suppose that a barometer scale be divided into tenths of an inch and that a length of 9 divisions of such a scale be divided into 10 parts for a vernier (fig. 5); and suppose that the divisions of the vernier be numbered consecutively from zero at the origin to 10 at the upper extremity. If, now, by means of the movable rack and pinion, the bottom or zero division of the vernier be brought level with the top of the mercurial column, and that division falls into exact coincidence with a division of the main scale, then the height of the column will correspond with the scale reading indicated. In such a case the top of the vernier will also exactly coincide with a scale division, but none of the intermediate divisions will be evenly abreast of such a division; the division marked "1" will fall short of a scale division by one-tenth of 1 division of the scale, or by 0.01 inch; that marked "2" by two-tenths of a division, or 0.02 inch; and so on. If the vernier, instead of having the zero coincide with a scale division, has the division "1" in such coincidence, it follows that the mercurial column stands at 0.01 inch above that scale division which is next below the zero; for the division "2," at 0.02 inch; and similarly for the others. In the case portrayed in figure 5, the reading of the column is 29.81 inches, the scale division next below the zero being 29.80 inches, while the fact that the first division is abreast a mark of the scale shows that 0.01 inch must be added to this to obtain the exact reading.

Had an example been chosen in which 8 vernier divisions covered 9 scale divisions—that is, where the number of vernier divisions was 1 less than the number of scale divisions covered—the principle would still have applied. But, instead of the length of 1 division of the vernier falling short of a division of the scale by one-tenth the length of the latter, it would have fallen beyond by one-eighth. To read in such a case it would therefore be necessary to number the vernier divisions from up downward and to regard the subdivisions as $\frac{1}{80}$ instead of 0.01 inch.

It is a general rule that the smallest measure to which a vernier reads is equal to the length of 1 division of the scale divided by the number of divisions of the vernier; hence, by varying either the scale or the vernier, we may arrive at any subdivision that may be desired.

53. The Sea Barometer is arranged as described for the instrument assumed in the illustration; the scale divisions are tenths of an inch, and the vernier has 10 divisions, whence it reads to 0.01 inch. It is not necessary to seek a closer reading, as complete accuracy is not attainable in observing the height of a barometer on a vessel at sea, nor is it essential. The Standard Barometer on shore, however, is capable of very exact reading; hence each scale division is made equal to half a tenth, or 0.05 inch, while a vernier covering 24 such divisions is divided into 25 parts; hence the column may be read to 0.002 inch.

54. To adjust the vernier for reading the height of the mercurial column the eye should be brought exactly on a level with the top of the column; that is, the line of sight should be at right angles to the scale. When properly set, the front and rear edges of the vernier and the uppermost point of the mercury should all be in the line of sight. A piece of white paper, held at the back of the tube so as to reflect the light, assists in accurately setting the vernier by day, while a small bull's-eye lamp held behind the instrument enables the observer to get a correct reading at night. When observing the barometer it should hang freely, not being inclined by holding or even by touch, because any inclination will cause the column to rise in the tube.

55. Other things being equal, the mercury will stand higher in the tube when it is warm than when it is cold, owing to expansion. For the purposes of comparison, all barometric observations are reduced to a standard which assumes 32° F. as the temperature of the mercurial column, and 62° F. as that of the metal scale; it is therefore important to make this reduction, as well as that for instrumental error (art. 57), in order to be enabled to compare the true barometric pressure with the normal that may be expected for any locality. The following table gives the value of this correction for each 2° F., the plus sign showing that the correction is to be added to the reading of the ship's barometer and the minus sign that it is to be subtracted:

Temperature.	Correction.	Temperature.	Correction.	Temperature.	Correction.	Temperature.	Correction.
°	*Inch.*	°	*Inch..*	°	*Inch.*	°	*Inch.*
20	+0.02	40	−0.03	60	−0.09	80	−0.14
22	+0.02	42	−0.04	62	−0.09	82	−0.14
24	+0.01	44	−0.04	64	−0.09	84	−0.15
26	+0.01	46	−0.05	66	−0.10	86	−0.15
28	0.00	48	−0.05	68	−0.10	88	−0.16
30	0.00	50	−0.06	70	−0.11	90	−0.16
32	−0.01	52	−0.06	72	−0.12	92	−0.17
34	−0.02	54	−0.07	74	−0.12	94	−0.17
36	−0.02	56	−0.07	76	−0.13	96	−0.18
38	−0.03	58	−0.08	78	−0.13	98	−0.18

As an example, let the observed reading of the mercurial barometer be 29.95 inches, and the temperature as given by the attached thermometer 74°; then we have:

	″
Observed height of the mercury	29.95
Correction for temperature (74°)	—0.12
Height of the mercury at standard temperature	29.83

56. THE ANEROID BAROMETER.—This is an instrument in which the pressure of the air is measured by means of the elasticity of a plate of metal. It consists of a cylindrical brass box, the metal in the sides being very thin; the contained air having been partially, though not completely, exhausted, the box is hermetically sealed. When the pressure of the atmosphere increases the inclosed air is compressed, the capacity of the box is diminished, and the two flat ends approach each other; when the pressure of the atmosphere decreases, the ends recede from one another in consequence of the expansion of the inclosed air. By means of a combination of levers, this motion of the ends of the box is communicated to an index pointer which travels over a graduated dial plate, the mechanical arrangement being such that the motion of the ends of the box is magnified many times, a very minute movement of the box making a considerable difference in the indication of the pointer. The graduations of the aneroid scale are obtained by comparison with the correct readings of a standard mercurial barometer under normal and reduced atmospheric pressure.

The thermometer attached to the aneroid barometer is merely for convenience in indicating the temperature of the air, but as regards the instrument itself no correction for temperature can be applied with certainty. Aneroids, as now manufactured, are almost perfectly compensated for temperature by the use of different metals having unequal coefficients of expansion; they ought, therefore, to show the same pressure at all temperatures.

The aneroid barometer, from its small size and the ease with which it may be transported, can often be usefully employed under circumstances where a mercurial barometer would not be available. It also has an advantage over the mercurial instrument in its greater sensitiveness, and the fact that it gives earlier indications of change of pressure. It can, however, be relied upon only when frequently compared with a standard mercurial barometer; moreover, considerable care is required in its handling; while slight shocks will not ordinarily affect it, a severe jar or knock may change its indications by a large amount.

When in use the aneroid barometer may be suspended vertically or placed flat, but changing from one position to another ordinarily makes a sensible change in the readings; the instrument should always, therefore, be kept in the same position, and the errors determined by comparisons made while occupying its customary place.

57. COMPARISON OF BAROMETERS.—To determine the reliability of the ship's barometer, whether mercurial or aneroid, comparisons should from time to time be made with a standard barometer. Nearly all instruments read either too high or too low by a small amount. These errors arise, in a mercurial barometer, from the improper placing of the scale, lack of uniformity of caliber of the glass tube, or similar causes; in an aneroid, which is less accurate and in which there is even more necessity for frequent comparisons, errors may be due to derangement of any of the various mechanical features upon which its working depends. The errors of the barometer should be determined for various heights, as they are seldom the same at all parts of the scale.

In the principal ports of the world standard barometers are observed at specified times each day, and the readings, reduced to zero and to sea level, are published. It is therefore only necessary to read the barometer on shipboard at those times and, if a mercurial instrument is used, to note the attached thermometer and apply the correction for temperature (art. 55). It is evident that a comparison of the heights by reduced standard and by the ship's barometer will give the correction to be applied to the latter, including the instrumental error, the reduction to sea level, and the personal error of the observer. In the United States, standard barometer readings are made by the Weather Bureau.

Aneroid barometers may be adjusted for instrumental error by moving the index hand, but this is usually done only in the case of errors of considerable magnitude.

58. Determination of Heights by Barometer.—The barometer may be used to determine the difference in heights between any two stations by means of the difference in atmospheric pressure between them. An approximate rule is to allow 0.0011 inch for each difference in level of 1 foot, or, more roughly, 0.01 inch for every 9 feet.

A very exact method is afforded by Babinet's formula. If B_0 and B represent the barometric pressure (corrected for all sources of instrumental error) at the lower and at the upper stations respectively, and t_0 and t the corresponding temperatures of the air; then,

$$\text{Diff. in height} = C \times \frac{B_0 - B}{B_0 + B};$$

if the temperatures be taken by a Fahrenheit thermometer,

$$C \text{ (in feet)} = 52,494 \left(1 + \frac{t_0 + t - 64}{900}\right);$$

if a centigrade thermometer is used,

$$C \text{ (in meters)} = 16,000 \left(1 + \frac{2(t_0 + t)}{1000}\right).$$

THE THERMOMETER.

59. The *Thermometer* is an instrument for indicating temperature. In its construction advantage is taken of the fact that bodies are expanded by heat and contracted by cold. In its most usual form the thermometer consists of a bulb filled with mercury, connected with a tube of very fine cross-sectional area, the liquid column rising or falling in the tube according to the volume of the mercury due to the actual degree of heat, and the height of the mercury indicating upon a scale the temperature; the mercury contained in the tube moves in a vacuum produced by the expulsion of the air through boiling the mercury and then closing the top of the tube by means of the blowpipe.

There are three classes of thermometer, distinguished according to the method of graduating the scale as follows: the *Fahrenheit,* in which the freezing point of water is placed at 32° and its boiling point (under normal atmospheric pressure) at 212°; the *Centigrade,* in which the freezing point is at 0° and the boiling point at 100°; and the *Réaumur,* in which these points are at 0° and 80°, respectively. The Fahrenheit thermometer is generally used in the United States and England. Tables will be found in this work for the interconversion of the various scale readings (Table 31).

60. The thermometer is a valuable instrument for the mariner, not only by reason of the aid it affords him in judging meteorological conditions from the temperature of the air and the amount of moisture it contains, but also for the evidences it furnishes at times, through the temperature of the sea water, of the ship's position and the probable current that is being encountered.

61. The thermometers employed in determining the temperature of the air (wet and dry bulb) and of the water at the surface, should be mercurial, and of some standard make, with the graduation etched upon the glass stem; they should be compared with accurate standards, and not accepted if their readings vary more than 1° from the true at any point of the scale.

62. The dry-bulb thermometer gives the temperature of the free air. The wet-bulb thermometer, an exactly similar instrument, the bulb of which is surrounded by an envelope of moistened cloth, gives what is known as the *temperature of evaporation,* which is always somewhat less than the temperature of the free air. From the difference of these two temperatures the observer may determine the proximity of the air to saturation; that is, how near the air is to that point at which it will be obliged to precipitate some of its moisture (water vapor) in the form of liquid. With the envelope of the wet bulb removed, the two thermometers should read precisely the same; otherwise they are practically useless.

The two thermometers, the wet and the dry bulb, should be hung within a few inches of each other, and the surroundings should be as far as possible identical. In practice the two thermometers[a] are generally inclosed within a small lattice case, such as that shown in figure 6; the case should be placed in a position on deck remote from any source of artificial heat, sheltered from the direct rays of the sun, and from the rain and spray, but freely exposed to the circulation of the air; the door should be kept closed except during the process of reading. The cloth envelope of the wet bulb should be a single thickness of fine muslin, tightly stretched over the bulb, and tied with a fine thread. The wick which serves to carry the water from the cistern to the bulb should consist of a few threads of lamp cotton, and should be of sufficient length to admit of two or three inches being coiled in the cistern. The muslin envelope of the wet bulb should be at all times thoroughly moist, but not dripping.

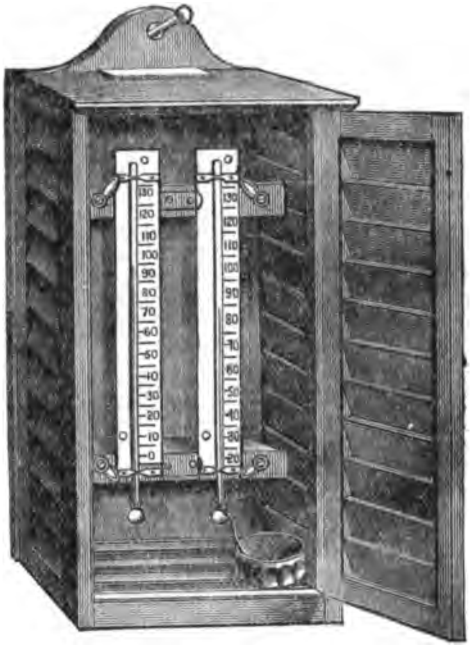
FIG. 6.

When the temperature of the air falls to 32° F. the water in the wick freezes, the capillary action is at an end, the bulb in consequence soon becomes quite dry, and the thermometer no longer shows the temperature of evaporation. At such times the bulb should be thoroughly wetted with ice-cold water shortly before the time of observation, using for this purpose a camel's hair brush or feather; by this process the temperature of the wet bulb is temporarily raised above that of the dry, but only for a brief time, as the water quickly freezes; and inasmuch as evaporation takes place from the surface of the ice thus formed precisely as from the surface of the water, the thermometer will act in the same way as if it had a damp bulb. The wet-bulb thermometer can not properly read higher than the dry, and if the reading of the wet bulb should be the higher, it may always be attributed to imperfections in the instruments.

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[a] Called a psychrometer.

63. Knowing the temperature of the wet and dry bulbs, the relative humidity of the atmosphere at the time of observation may be found from the following table:

Temperature of the air, dry-bulb thermometer.	Difference between dry-bulb and wet-bulb readings.									
	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°
°	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
24	87	75	62	50	38	26				
26	88	76	65	53	42	30				
28	89	78	67	56	45	34	24			
30	90	79	68	58	48	38	28			
32	90	80	70	61	51	41	32	23		
34	90	81	72	63	53	44	35	27		
36	91	82	73	64	55	47	38	30	22	
38	92	83	75	66	57	50	42	34	26	
40	92	84	76	68	59	52	44	37	30	22
42	92	84	77	69	61	54	47	40	33	26
44	92	85	78	70	63	56	49	43	36	29
46	93	85	79	72	65	58	51	45	38	32
48	93	86	79	73	66	60	53	47	41	35
50	93	87	80	74	67	61	55	49	43	37
52	94	87	81	75	69	63	57	51	46	40
54	94	88	82	76	70	64	59	53	48	42
56	94	88	82	77	71	65	60	55	50	44
58	94	89	83	78	72	67	61	56	51	46
60	94	89	84	78	73	68	63	58	53	48
62	95	89	84	79	74	69	64	59	54	50
64	95	90	85	79	74	70	65	60	56	51
66	95	90	85	80	75	71	66	61	57	53
68	95	90	85	81	76	71	67	63	58	54
70	95	90	86	81	77	72	68	64	60	55
72	95	91	86	82	77	73	69	65	61	57
74	95	91	86	82	78	74	70	66	62	58
76	95	91	87	82	78	74	70	66	63	59
78	96	91	87	83	79	75	71	67	63	60
80	96	92	87	83	79	75	72	68	64	61
82	96	92	88	84	80	76	72	69	65	62
84	96	92	88	84	80	77	73	69	66	63
86	96	92	88	84	81	77	73	70	67	63
88	96	92	88	85	81	77	74	71	67	64
90	96	92	88	85	81	78	74	71	68	65

The table may be readily understood. For example, if the temperature of the air (dry bulb) be 60°, and the temperature of evaporation (wet bulb) be 56°, the difference being 4°, look in the column headed "Temperature of the air" for 60°, and for the figures on the same line in column headed 4°; here 78 will be found, which means that the air is 78 per cent saturated with water vapor; that is, that the amount of water vapor present in the atmosphere is 78 per cent of the total amount that it could carry at the given temperature (60°). This total amount, or saturation, is thus represented by 100, and if there occurred any increase of the quantity of vapor beyond this point, the excess would be precipitated in the form of liquid. Over the ocean's surface the relative humidity is generally about 90 per cent, or even higher in the doldrums; over the land in dry winter weather it may fall as low as 40 per cent.

64. The sea water of which the temperature is to be taken should be drawn from a depth of 3 feet below the surface, the bucket used being weighted in order to sink it. The bulb of the thermometer should remain immersed in the water at least three minutes before reading, and the reading should be made with the bulb immersed.

THE LOG BOOK.

65. The *Log Book* is a record of the ship's cruise, and, as such, an important accessory in the navigation. It should afford all the data from which the position of the ship is established by the method of dead reckoning; it should also comprise a record of meteorological observations, which should be made not only for the purpose of foretelling the weather during the voyage, but also for contribution to the general fund of knowledge of marine meteorology.

66. A convenient form for recording the data, which is employed for the log books of United States naval vessels, is shown on page 32; beside the tabulated matter thus arranged, to which one page of the book is devoted, a narrative of the miscellaneous events of the day, written and signed by the proper officers, appears upon the opposite page.

LOG OF THE UNITED STATES .... *RATE,*

....

Hour.	Knots.	Tenths.	Reading of patent log.	Average.		Reading of engine counter.	Courses steered by standard compass.	Wind.		Barometer.		Temperature.			State of the weather by symbols.	Clouds.			State of the sea.
				Steam.	Revolutions.			Direction by standard compass.	Force.	Height, in inches.	Thermometer attained.	Air, dry bulb.	Air, wet bulb.	Water at surface.		Forms of, by symbols.	Moving from.	Amount, scale 0 to 10.	
A. M.																			
1																			
2																			
3																			
4																			
5																			
6																			
7																			
8																			
9																			
10																			
11																			
Noon.																			

8 a.m. Latitude ....
8 a.m. Longitude ....
Noon. D. R. Latitude ....
Noon. D. R. Longitude ....
Noon. Obs. Latitude ....
Noon. Obs. Longitude ....
Noon. Current Set ....
Noon. Current Drift ....
Noon. Made good Distance ....
Noon. Made good Course ....
8 p.m. Latitude ....
8 p.m. Longitude ....
Magazine temperatures:
Maximum ....
Minimum ....

Compass. Error on course ....
Compass. Variation ....
Compass. Deviation ....
Coal. Received ....
Coal. Expended ....
Coal. On hand ....
Fuel oil. Received ....
Fuel oil. Expended ....
Fuel oil. On hand ....
Water. Distilled ....
Water. Received ....
Water. Expended ....
Water. On hand ....

Drills and exercises.

Morning.	*Afternoon.*
First division	First division ....
Second division	Second division ....
Third division	Third division ....
Fourth division	Fourth division ....
Fifth division	Fifth division ....
Sixth division	Sixth division ....
Seventh division	Seventh division ....

67. For the most part, the nature of the information called for, with the method of recording it, will be apparent. A brief explanation is here given of such points as seem to require it.

68. THE WIND.—In recording the force of the wind the scale devised by the late Admiral Sir F. Beaufort is employed. According to this scale the wind varies from 0, a calm, to 12, a hurricane, the greatest velocity it ever attains. In the lower grades of the scale the force of the wind is estimated from the speed imparted to a man-of-war of the early part of the nineteenth century sailing full and by; in the higher grades, from the amount of sail which the same vessel could carry when close-hauled. The scale, with the estimated velocity of the wind in both statute and nautical miles per hour, is as follows:

Force of wind.	Conditions.	Velocity.		Mean pressure in pounds per square foot.
		Statute miles per hour.	Nautical miles per hour.	
0.—Calm	Full-rigged ship, all sails set, no headway	0 to 3	0 to 2.6	0.03
1.—Light air	Just sufficient to give steerage way	8	6.9	0.23
2.—Light breeze	Speed of 1 or 2 knots, "full and by"	13	11.3	0.62
3.—Gentle breeze	Speed of 3 or 4 knots, "full and by"	18	15.6	1.2
4.—Moderate breeze	Speed of 5 or 6 knots, "full and by"	23	20.0	1.9
5.—Fresh breeze	All plain sail, "full and by"	28	24.3	2.9
6.—Strong breeze	Topgallant sails over single-reefed topsails	34	29.5	4.2
7.—Moderate gale	Double-reefed topsails	40	34.7	5.9
8.—Fresh gale	Treble-reefed topsails (or reefed upper topsails and courses).	48	41.6	8.4
9.—Strong gale	Close-reefed topsails and courses (or lower topsails and courses).	56	48.6	11.5
10.—Whole gale	Close-reefed main topsail and reefed fore-sail (or lower main topsail and reefed foresail).	65	56.4	15.5
11.—Storm	Storm staysails	75	65.1	20.6
12.—Hurricane	Under bare poles	90 and over.	78.1 and over.	29.6

69. When steaming or sailing with any considerable speed, the apparent direction and force of the wind, as determined from a vane flag, or pennant aboard ship, may differ materially from the true direction and force, the reason being that the air appears to come from a direction and with a force dependent, not only upon the wind itself, but also upon the motion of the vessel. For instance, suppose that the wind has a velocity of 20 knots an hour (force 4), and take the case of two vessels, each steaming 20 knots, the first with the wind dead aft, the second with the wind dead ahead. The former vessel will be moving with the same velocity as the air and in the same direction; the velocity of the wind relatively to the ship will thus be zero; on the vessel an apparent calm will prevail and the pennant will hang up and down. The latter vessel will be moving with the same velocity as the air, but in the opposite direction; the relative velocity of the two will thus be the sum of the two velocities, or 40 knots an hour, and on the second vessel the wind will apparently have the velocity corresponding very nearly with a fresh gale. Again, it might be shown that in the case of a vessel steaming west at the rate of 20 knots, with the wind blowing from north with the velocity of 20 knots an hour, the velocity with which the air strikes the ship as a result of the combined motion will be 28 knots an hour, and the direction from which it comes will be NW. If, therefore, the effect of the speed of the ship is neglected the wind will be recorded as NW., force 6, when in reality it is north, force 4.

In order to make a proper allowance for this error and arrive at the true direction and force of the wind, Table 32 may be entered with the ship's speed and the apparent direction and force of the wind as arguments, and the true direction and force will be found.

70. Weather.—To designate the weather a series of symbols devised by the late Admiral Beaufort is employed. The system employed in the United States Navy is as follows:

b.—Clear blue sky.
c.—Clouds.
d.—Drizzling, or light rain.
f.—Fog, or foggy weather.
g.—Gloomy, or dark, stormy-looking weather.
h.—Hail.
l.—Lightning.
m.—Misty weather.
o.—Overcast.
p.—Passing showers of rain.
q.—Squally weather.
r.—Rainy weather, or continuous rain.
s.—Snow, snowy weather, or snow falling.
t.—Thunder.
u.—Ugly appearances, or threatening weather.
v.—Variable weather.
w.—Wet, or heavy dew.
z.—Hazy weather.

To indicate great intensity of any feature, its symbol may be underlined; thus: $\underline{r}$., heavy rain.

71. Clouds.—The following are the principal forms of clouds, named in the order of the altitude above the earth at which they usually occur, beginning with the most elevated. The symbols by which each is designated follows its name:

1. Cirrus (*Ci.*).—Detached clouds, delicate and fibrous looking, taking the form of feathers, generally of a white color, sometimes arranged in belts which cross a portion of the sky in great circles, and, by an effect of perspective, converging toward one or two opposite points of the horizon.

2. Cirro-Stratus (*Ci.-S.*).—A thin, whitish sheet, sometimes completely covering the sky and only giving it a whitish appearance, or at others presenting, more or less distinctly, a formation like a tangled web. This sheet often produces halos around the sun and moon.

3. Cirro-Cumulus (*Ci.-Cu.*).—Small globular masses or white flakes, having no shadows, or only very slight shadows, arranged in groups and often in lines.

4. Alto-Cumulus (*A.-Cu.*).—Rather large globular masses, white or grayish, partially shaded, arranged in groups or lines, and often so closely packed that their edges appear confused. The detached masses are generally larger and more compact at the center of the group; at the margin they form into finer flakes. They often spread themselves out in lines in one or two directions.

5. Alto-Stratus (*A.-S.*).—A thick sheet of a gray or bluish color, showing a brilliant patch in the neighborhood of the sun or moon, and which, without causing halos, may give rise to coronæ. This form goes through all the changes like the Cirro-Stratus, but its altitude is only half so great.

6. Strato-Cumulus (*S.-Cu.*).—Large globular masses or rolls of dark cloud, frequently covering the whole sky, especially in winter, and occasionally giving it a wavy appearance. The layer of Strato-Cumulus is not, as a rule, very thick, and patches of blue sky are often visible through the intervening spaces. All sorts of transitions between this form and the Alto-Cumulus are noticeable. It may be distinguished from Nimbus by its globular or rolled appearance and also because it does not bring rain.

7. Nimbus (*N.*).—Rain clouds; a thick layer of dark clouds, without shape and with ragged edges, from which continued rain or snow generally falls. Through the openings of these clouds an upper layer of Cirro-Stratus or Alto-Stratus may almost invariably be seen. If the layer of Nimbus separates into shreds or if small loose clouds are visible floating at a low level underneath a large nimbus, they may be described as Fracto-Nimbus (Fr.-N.), the "scud" of sailors.

8. Cumulus (*Cu.*).—Wool-pack clouds; thick clouds of which the upper surface is dome-shaped and exhibits protuberances, while the base is horizontal. When these clouds are opposite the sun the surfaces usually presented to the observer have a greater brilliance than the margins of the protuberances. When the light falls aslant, they give deep shadows; when, on the contrary, the clouds are on the same side as the sun, they appear dark, with bright edges. The true Cumulus has clear superior and inferior limits. It is often broken up by strong winds, and the detached portions undergo continual changes. These may be distinguished by the name of Fracto-Cumulus (*Fr.-Cu.*).

9. Cumulo-Nimbus (*Cu.-N.*).—The thunder-cloud or shower-cloud; heavy masses of clouds rising in the form of mountains, turrets, or anvils, generally having a sheet or screen of fibrous appearance above, and a mass of clouds similar to Nimbus underneath. From the base there usually fall local showers of rain or of snow (occasionally hail or soft hail).

10. Stratus (*S.*).—A horizontal sheet of lifted fog; when this sheet is broken up into irregular shreds by the wind or by the summits of mountains, it may be distinguished by the name of Fracto-Stratus (*Fr.-S.*).

72. In the scale for the amount of clouds 0 represents a sky which is cloudless and 10 a sky which is completely overcast.

73. State of Sea.—The state of the sea is expressed by the following system of symbols:

B.—Broken or irregular sea.
C.—Chopping, short, or cross sea.
G.—Ground swell.
H.—Heavy sea.
L.—Long rolling sea.
M.—Moderate sea or swell.
R.—Rough sea.
S.—Smooth sea.
T.—Tide-rips.

Note.—There are various publications issued by the Hydrographic Office dealing with special features of navigation, which should be regularly consulted. Among the most important of these are:

Pilot charts of the various oceans furnish information regarding the drift of derelicts, ice, and floating obstructions, the tracks of storms, average conditions of wind and weather, ocean currents, magnetic variation, etc.

Hydrographic Bulletin, weekly, gives more detailed facts than the Pilot Charts regarding ice, wrecks, and derelicts; also items on port facilities, use of oil to calm the sea, and miscellaneous items of use and interest to mariners.

Daily Memorandum, published at the main office at Washington, also makes public these items through the Branch Hydrographic Offices.

Notice to Mariners, weekly, gives changes in aids to navigation (lights, buoyage, harbor constructions), dangers to navigation (rocks, shoals, banks, bars), important new soundings, and, in general, all such facts as affect mariners' charts, manuals, and pilots or sailing directions.

CHAPTER III.

THE COMPASS ERROR.

CAUSES OF THE ERROR.

74. The properties of magnets are such that when two magnets are near enough together to exert a mutual influence, those poles which possess like magnetism repel each other, and those which possess unlike magnetism attract each other.

The earth is a magnetized body, and acts like a great spherical magnet with poles of unlike magnetism situated within the Arctic and Antarctic circles close to longitudes 97° west and 155° east of Greenwich, respectively. In common with magnets, the earth is surrounded by a region in which magnetic influence is exercised upon the compass, giving the magnetic needle a definite direction in each locality and causing the end which we name the north pole of the compass to be directed in general toward the region of the magnetic pole in the geographical north and the south end toward the region of the magnetic pole in the geographical south.

The north end of the compass—north-seeking, as it is sometimes designated for clearness—will be that end which has opposite polarity to the earth's north magnetic pole, or, otherwise stated, which possesses like magnetism with the earth's south magnetic pole.

75. By reason of the fact that the magnetic pole in each hemisphere differs in geographical position by a large and unequal amount from the geographical pole, we are made aware that the earth is not magnetized symmetrically with reference to the geographical poles. Hence the directive influence of the earth's magnetism will not in general cause the compass needle to point in the direction of the true meridian, but each compass point will differ from the corresponding true point by an amount varying according to the geographical locality. The angle representing this difference is the *Variation of the Compass*, sometimes also called the *Magnetic Declination*. It is the angle between the plane of the true meridian and a vertical plane passing through a freely suspended magnetic needle influenced solely by the earth's magnetism.

The variation not only changes as one travels from place to place on the earth, being different in different localities, but in every locality, besides the minor periodic movements of the needle known as the diurnal, monthly, and annual variations, which are not of material concern to the mariner, there is a progressive change which extends through centuries of time and amounts to large alterations in the pointing of the compass. In taking account of the effect produced by the variation of the compass, the navigator must therefore be sure that the variation used is correct not only for the *place*, but also for the *time* under consideration.

Occasionally the magnetic needle is subject to spasmodic fluctuations of the earth's magnetism lasting from a brief period to several days. These are called *magnetic storms*, and are due to sudden changes in the electric currents which circulate within the earth and in the region surrounding the earth. They come apparently at random, and may occur nearly simultaneously over the whole world or be restricted to a certain region. The range of their effect upon the compass does not often exceed the half of a degree in the lower latitudes, and hence the navigator need only be concerned with them in the higher latitudes where he may look to the aurora as an indication of their occurrence.

76. Besides the error thus produced in the indications of the compass, a further one, due to *Local Attraction*, may arise from extraneous influences due to natural magnetic attraction in the vicinity of the vessel. Instances of this are quite common when a ship is in port, as she may be in close proximity to vessels, docks, machinery, or other masses of iron or steel. It is also encountered in the shallow waters of the sea in localities where the mineral substances in the earth itself possess magnetic qualities—as, for example, at certain places in Lake Superior and at others off the coast of Australia. When due to the last-named cause, it may be a source of great danger to the mariner, but, fortunately, the number of localities subject to local attraction is limited. The amount of this error can seldom be determined except by survey; if known, it might properly be included with the variation and treated as a part thereof.

77. In addition to the variation, the compass ordinarily has a still further error in its indications, which arises from the effect exerted upon it by masses of magnetic metal within the ship itself. This is known as the *Deviation of the Compass*. For reasons that will be explained later, it differs in amount for each heading of the ship, and, further, the character of the deviations undergoes modification as a vessel proceeds from one geographical locality to another.

APPLYING THE COMPASS ERROR.

78. From what has been explained, it may be seen that there are three methods by which bearings or courses may be expressed: (*a*) *true*, when they refer to the angular distance from the earth's geographical meridian; (*b*) *magnetic*, when they refer to the angular distance from the earth's magnetic meridian, and must be corrected for variation to be converted into true; and (*c*) *by compass*, when they refer to the angular distance from the north indicated by the compass on a given heading of the ship, and must be corrected for the deviation on that heading for conversion to magnetic, and for both deviation and variation for conversion to true bearings or courses. The process of applying the errors under all circumstances is one of which the navigator must make himself a thorough master; the various problems of conversion are constantly arising; no course can be set nor bearing plotted without involving the application of this problem, and a mistake in its solution may produce serious consequences. The student is therefore urged to give it his most careful attention.

79. When the effect of a compass error, whether arising from variation or from deviation, is to draw the north end of the compass needle to the right, or eastward, the error is named *east*, or is marked +; when its effect is to draw the north end of the needle to the left or westward, it is named *west*, or marked −.

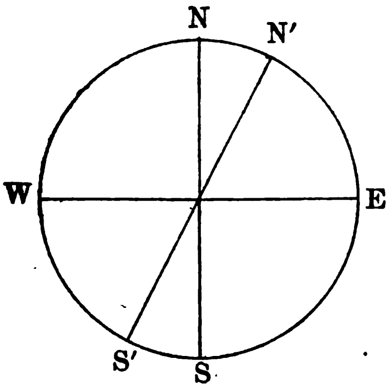

FIG. 7.

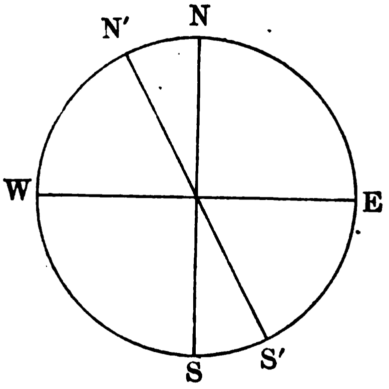

FIG. 8.

Figures 7 and 8 represent, respectively, examples of easterly and westerly errors. In both cases consider that the circles represent the observer's horizon, N and S being the correct north and south points in each case. If N′ and S′ represent the corresponding points indicated by a compass whose needle is deflected by a compass error, then in the first case, the north end of the needle being drawn to the right or east, the error will be easterly or positive, and in the second case, the north end of the needle being drawn to the left or west, the compass error will be westerly or negative.

Considering figure 7, if we assume the easterly error to amount to one point, it will be seen that if a direction of N. by W. is indicated by the compass, the correct direction should be north, or one point farther to the right. If the compass indicates north, the correct bearing is N. by E.; that is, still one point to the right. If we follow around the whole card, the same relation will be found in every case, the corrected bearing being always one point to the right of the compass bearing. Conversely, if we regard figure 8, assuming the same amount of westerly error, a compass bearing of N. by E. is the equivalent of a correct bearing of north, which is one point to the left; and this rule is general throughout the circle, the corrected direction being always to the left of that shown by the compass.

80. Having once satisfied himself that the general rule holds, the navigator may save the necessity of reasoning out in each case the direction in which the error must be applied, and need only charge his mind with some single formula which will cover all cases. Such a one is the following:

When the CORRECT *direction is to the* RIGHT, *the error is* EAST.

The words *correct-right-east,* in such a case, would be the key to all of his solutions. With easterly error, if he had a compass course to change to a corrected one, he would know that to obtain the result the error must be applied to the right; and, if it were desired to change a correct course to one indicated by compass, the error would be applied to the left. If a correct bearing is to be compared with a compass bearing to find the compass error, when the correct bearing is to the right, the error is easterly; and when the correct bearing is to the left, the error is westerly.

81. It must be remembered that the word *east* is equivalent to *right* in dealing with the compass error, and *west* to *left,* even though they involve an apparent departure from the usual rules. If a vessel steers NE. by compass with one point easterly error, her corrected course is NE. by E.; but if she steers SE., the corrected course is not SE. by E., but SE. by S. Another caution may be necessary to avoid confusion; the navigator should always regard himself as facing the point under consideration when he applies an error; one point westerly error on South will bring a corrected direction to S. by E.; but if we applied one point to the left of South while looking at the compass card in the usual way—north end up—S. by W. would be the point arrived at, and a mistake of two points would be the result.

82. In the foregoing explanation reference has been made to "correct" directions and "compass errors" without specifying "magnetic" and "true" or "variation" and "deviation." This has been done in order to make the statements apply to all cases and to enable the student to grasp the subject in its general bearing without confusion of details.

Actually, as has already been pointed out, directions given may be true, magnetic, or by compass. By applying variation to a magnetic bearing we correct it and make it true, by applying a deviation to a compass bearing we correct it to magnetic, and by applying to it the combined deviation and variation we correct it to true. Whichever of these operations is undertaken, and whichever of the errors is considered, the process of correction remains the same; the correct direction is always to the right, when the error is east, by the amount of that error.

Careful study of the following examples will aid in making the subject clear:

EXAMPLES: A bearing taken by a compass free from deviation is 76°; variation, 5° W.; required the true bearing. 71°.

A bearing taken by a similar compass is NW. by W. ½ W.; variation, ¼ pt. W.; required the true bearing. NW. by W. ¾ W.

A vessel steers 153° by compass; deviation on that heading, 3° W.; variation in the locality, 12° E.; required the true course. 162°.

A vessel steers S. by W. ½ W.; deviation, ¼ pt. W.; variation, 1 pt. E.; required the true course. SSW. ¼ W.

It is desired to steer the magnetic course 322°; deviation, 4° E.; required the course by compass. 318°.

The true course between two points is found to be W. ⅞ N.; variation, 1¼ pt. E.; no deviation; required the compass course. W. ⅜ S.

True course to be made, 55°; deviation, 7° E.; variation, 14° W.; required the course by compass. 62°.

A vessel passing a range whose direction is known to be 200°, magnetic, observes the bearing by compass to be 178°; required the deviation. 22° E.

The sun's observed bearing by compass is 91°; it is found by calculation to be 84° (true); variation, 8° W.; required the deviation. 1° E.

FINDING THE COMPASS ERROR.

83. The variation of the compass for any given locality is found from the charts. A nautical chart always contains information from which the navigator is enabled to ascertain the variation for any place within the region embraced and for any year. Beside the information thus to be acquired from local charts, special charts are published showing the variation at all points on the earth's surface.

84. The deviation of the compass, varying as it does for every ship, for every heading, and for every geographical locality, must be determined by the navigator, for which purpose various methods are available.

Whatever method is used, the ship must be swung in azimuth and an observation made on each of the headings upon which the deviation is required to be known. If a new iron or steel ship is being swung for the first time, observations should be made on each of the twenty-four 15° rhumbs into which the compass card is divided. At later swings, especially after correctors have been applied, or in the case of wooden ships, twelve 15° rhumbs will suffice—or, indeed, only six. In case it is not practicable to make observations on exact 15° rhumbs, they should be made as near thereto as practicable and plotted on the Napier diagram (to be explained hereafter), whence the deviations on exact 15° rhumbs may be found.

85. In swinging ship for deviations the vessel should be on an even keel and all movable masses of iron in the vicinity of the compass secured as for sea, and the compass accurately centered in the binnacle. The vessel, upon being placed on any heading, should be steadied there for three or four minutes before the observation is made, in order that the compass card may come to rest and the magnetic conditions assume a settled state. To assure the greatest accuracy the ship should first be swung to starboard, then to port, and the mean of the two deviations on each course taken. Ships may be swung under their own steam, or with the assistance of a tug, or at anchor, where the action of the tide tends to turn them in azimuth (though in this case it is difficult to get them steadied for the requisite time on each heading), or at anchor, by means of springs and hawsers.

86. The deviation of all compasses on the ship may be obtained from the same swing, it being required to make observations with the standard only. To accomplish this it is necessary to record the ship's head by all compasses at the time of steadying on each even rhumb of the standard; applying the deviation, as ascertained, to the heading by standard, gives the magnetic heads, with which the direction of the ship's head by each other compass may be compared, and the deviation thus obtained. Then a complete table of deviations may be constructed as explained in article 94.

87. There are four methods for ascertaining the deviations from swinging; namely, by *reciprocal bearings*, by *bearings of the sun*, by *ranges*, and by a *distant object*.

88. Reciprocal Bearings.—One observer is stationed on shore with a spare compass placed in a position free from disturbing magnetic influences; a second observer is at the standard compass on board ship. At the instant when ready for observation a signal is made, and each notes the bearing of the other. The bearing by the shore compass, reversed, is the magnetic bearing of the shore station from the ship, and the difference between this and the bearing by the ship's standard compass represents the deviation of the latter.

In determining the deviations of compasses placed on the fore-and-aft amidship line, when the distribution of magnetic metal to starboard and port is symmetrical, the shore compass may be replaced by a dumb compass, or pelorus, or by a theodolite in which, for convenience, the zero of the horizontal graduated circle may be termed north; the reading of the shore instrument will, of course, not represent magnetic directions, but by assuming that they do we obtain a series of fictitious deviations, the mean value of which is the error common to all. Upon deducting this error from each of the fictitious deviations, we obtain the correct values.

If ship and shore observers are provided with watches which have been compared with one another, the times may be noted at each observation, and thus afford a means of locating errors due to misunderstanding of signals.

89. Bearings of the Sun.—In this method it is required that on each heading a bearing of the sun be observed by compass and the time noted at the same moment by a chronometer or watch. By means which will be explained in Chapter XIV, the true bearing of the sun may be ascertained from the known data, and this, compared with the compass bearing, gives the total compass error; deducting from the compass error the variation, there remains the deviation. The variation used may be that given by the chart, or, in the case of a compass affected only by symmetrically placed iron or steel, may be considered equal to the mean of all the total errors. Other celestial bodies may be observed for this purpose in the same manner as the sun.

This method is important as being the most convenient one available for determining the compass error at sea. When adjusting compasses much time will be saved by this simple modification of a detail:

Instead of tabulating magnetic azimuths for given stated times in advance, draw on cross-section paper a curve whose ordinates are minutes of local apparent time and whose abscissæ are degrees of magnetic azimuth, that is, true azimuth corrected for variation. Then for any given instant (the navigator's watch being set to local apparent time) the magnetic azimuth may be read directly from the curve. The difference between the magnetic azimuth of the sun and its compass bearing is, of course, the deviation of the compass on that particular heading.

90. Ranges.—In many localities there are to be found natural or artificial range marks which are clearly distinguishable, and which when in line lie on a known magnetic bearing. By steaming about on different headings and noting the compass bearing of the ranges each time of crossing the line that they mark, a series of deviations may be obtained, the deviation of each heading being equal to the difference between the compass and the magnetic bearing.

91. Distant Object.—A conspicuous object is selected which must be at a considerable distance from the ship and upon which there should be some clearly defined point for taking bearings. The direction of this object by compass is observed on successive headings. Its true or magnetic bearing is then found and compared with the compass bearings, whence the deviation is obtained.

The true or the magnetic bearing may be taken from the chart. The magnetic bearing may also be found by setting up a compass ashore, free from foreign magnetic disturbance, in range with the object and the ship, and observing the bearing of the object; or the magnetic bearing may be assumed to be the mean of the compass bearings.

In choosing an object for use in this method care must be taken that it is at such a distance that its bearing from the ship does not practically differ as the vessel swings in azimuth. If the ship is swung at anchor, the distance should be not less than 6 miles. If swung under way, the object must be so far that the parallax (the tangent of which may be considered equal to half the diameter of swinging divided by the distance) shall not exceed about 30′.

92. In all of the methods described it will be found convenient to arrange the results in tabular form. In one column record the ship's head by standard compass, and abreast it in successive columns the observations from which the deviation is determined on that heading, and finally write the deviation itself. When the result of the swing has been worked up, another table is constructed showing simply the headings and the corresponding deviations. This is known as the *Deviation Table* of the compass. If compensation is to be attempted, this table is the basis of the operation; if not, the deviation tables of the standard and steering compass should be posted in such place as to be accessible to all persons concerned with the navigation of the ship.

93. Let it be assumed that a deviation table has been found and that the values are as follows:

Deviation table.

Ship's head by standard compass.	Deviation.	Ship's head by standard compass.	Deviation.
°	° ′	°	° ′
North 0	−15 29	South 180	+17 52
15	−14 53	195	+23 47
30	−13 16	210	+27 07
NE 45	−11 19	SW 225	+25 35
60	− 9 59	240	+21 57
75	− 9 42	255	+15 54
East 90	− 9 06	West 270	+ 9 56
105	− 9 01	285	+ 1 56
120	− 7 51	300	− 4 09
SE 135	− 5 54	NW 315	−10 20
150	− 2 16	330	−13 37
165	+ 8 29	345	−16 01

We have from the table the amount of deviation on each compass heading; therefore, knowing the ship's head by compass, it is easy to pick out the corresponding deviation and thus to obtain the magnetic heading. But if we are given the magnetic direction in which it is desired to steer and have to find the corresponding compass course, the problem is not so simple, for we are not given deviations on magnetic heads, and where the errors are large it may not be assumed that they are the same as on the corresponding compass headings. For example, with the deviation table just given, suppose it is required to determine the compass heading corresponding to 165°, magnetic.

The deviation corresponding to 165°, per compass, is +8½°. If we apply this to 165°, magnetic, we have 156½° as the compass course. But, consulting the table, it may be seen that the deviation corresponding to 156½°, per compass, is +2½°, and therefore if we steer that course the magnetic direction will be 159°, and not 165°, as desired.

A way of arriving at the correct result is to make a series of trials until a course is arrived at which fulfills the conditions. Thus, in the example given:

First trial.

Mag. course desired	165°
Try dev. on 165°	8½° E.
Trial comp. course	156½°
Dev. on 156½°	2½° E.
Mag. course made good	159°

Since this assumption carries the course 6° too far to the left, assume next a deviation on a course 3½° farther to the right than the one used here.

Second trial.

Mag. course desired	165°
Try dev. on 160°	5° E.
Trial comp. course	160°
Dev. on 160°	5°
Mag. course made good	165°

This happens to be exactly the compass course required. But it often occurs that further trials may be necessary.

94. The Napier Diagram.—A much more expeditious method for the solution of this problem is afforded by the *Napier Diagram*, and as that diagram also facilitates a number of other operations connected with compass work it should be clearly understood by the navigator. This admits of a graphic representation of the table of deviations of the compass by means of a curve; besides furnishing a ready means of converting compass into magnetic courses and the reverse, one of its chief merits is that if the deviation has been determined on a certain number of headings it enables one to obtain the most probable value of the deviation on any other course that the ship may head. The last-named feature renders it useful in making a table of deviations of compasses other than the standard when their errors are found as described in article 86.

95. The Napier diagram (fig. 9) represents the margin of a compass card cut at the north point and straightened into a vertical line; for convenience, it is usually divided into two sections, representing, respectively, the eastern and western semicircles. The vertical line is of a convenient length and divided into twenty-four equal parts corresponding to the 15° rhumbs of the compass, beginning at the top with North and continuing around to the right; it is also divided into 360 degrees, which are appropriately marked.

To obtain a complete curve, a sufficient number of observations should be taken while the ship swings through an entire circle. Generally, observations on every alternate 15° rhumb are enough to establish a good curve, but in cases where the maximum deviation reaches 40° it is preferable to observe on every 15° rhumb.

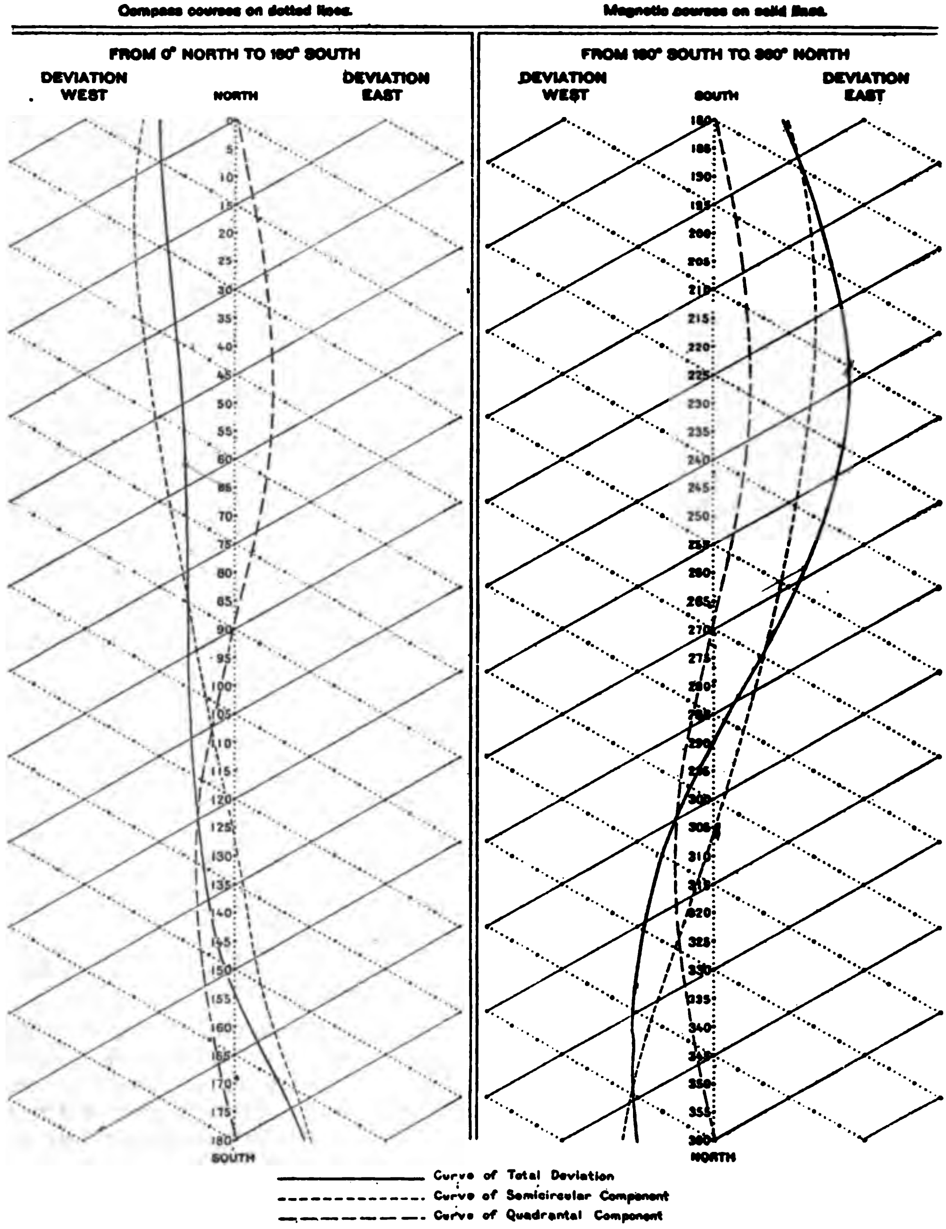

Fig. 9.

The curve shown in the full line on figure 9 corresponds to the table of deviations given in article 93.

From a given compass course to find the corresponding magnetic course, through the point of the vertical line representing the given compass course draw a line parallel to the *dotted* lines until the curve is intersected, and from the point of intersection draw another line parallel to the plain lines; the point on the scale where this last line cuts the vertical line is the magnetic course sought. The correctness of this solution will be apparent when we consider that the 60° triangles are equilateral, and therefore the distance measured along the vertical side will equal the distance measured along the inclined sides—that is, the deviation; and the direction will be correct, for the construction is such that magnetic directions will be to the right of compass directions when the deviation is easterly and to the left if westerly.

From a given magnetic course to find the corresponding compass course, the process is the same, excepting that the first line drawn should follow, or be parallel to, the *plain* lines, and the second, or return line, should be parallel to the dotted; and a proof similar to that previously employed will show the correctness of the result. As an example, the problem given in article 93 may be solved by the diagram, and the result will be found to accord with the solution previously given.

The vertical line is intersected at each 15° rhumb by two lines inclined to it at an angle of 60°, that line which is inclined upward to the right being drawn plain and the other dotted.

To plot a curve on the Napier diagram, if the deviation has been observed with the ship's head on given *compass* courses (as is usually the case with the standard compass), measure off on the vertical scale the number of degrees corresponding to the deviation and lay it down—to the right if easterly and to the left if westerly—on the *dotted* line passing through the point representing the ship's head; or, if the observation was not made on an even 15° rhumb, then lay it down on a line drawn parallel to the dotted ones through that division of the vertical line which represents the compass heading; if the deviation has been observed with the ship on given *magnetic* courses (as when deviations by steering compass are obtained by noting the ship's head during a swing on even 15° rhumbs of the standard), proceed in the same way, excepting that the deviation must be laid down on a *plain* line or a line parallel thereto. Mark each point thus obtained with a dot or small circle, and draw a free curve passing, as nearly as possible, through all the points.

THE THEORY OF DEVIATION.[a]

96. Features of the Earth's Magnetism.—It has already been stated that the earth acts like a great spherical magnet, with a pole in each hemisphere which is not coincident with the geographical pole; it has also a magnetic equator which lies close to, but not coincident with, the geographical equator.

A magnetic needle freely suspended at a point on the earth's surface, and undisturbed by any other than the earth's magnetic influence, will lie in the plane of the magnetic meridian and at an angle with the horizon depending upon the geographical position.

The magnetic elements of the earth which must be considered are shown in figure 10. The earth's *total force* is represented in direction and intensity by the line AB. Since compass needles are mechanically arranged to move only in a horizontal plane, it becomes necessary, when investigating the effect of the earth's magnetism upon them, to resolve the total force into two components which in the figure are represented by AC and AD. These are known, respectively, as the *horizontal* and *vertical components* of the earth's total force, and are usually designated as H and Z. The angle CAB, which the line of direction makes with the plane of the horizon, is called the *magnetic inclination* or *dip,* and denoted by θ.

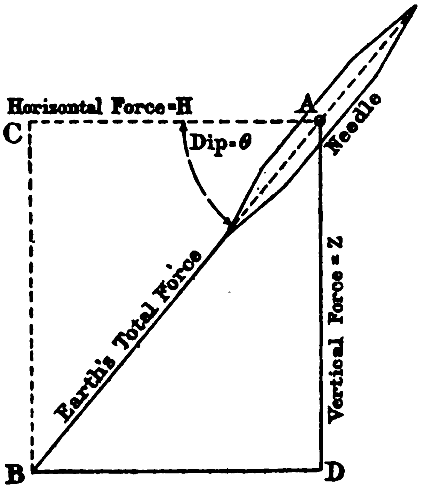

FIG. 10.

It is clear that the horizontal component will reduce to zero at the magnetic poles, where the needle points directly downward, and that it will reach a maximum at the magnetic equator, where the free needle hangs in a horizontal direction. The reverse is true of the vertical component and of the angle of dip.

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[a] As it is probable that the student will not have practical need of a knowledge of the theory of deviation and the compensation of the compass until after he has mastered all other subjects pertaining to Navigation and Nautical Astronomy, it may be considered preferable to omit the remainder of this chapter at first and return to it later.

Values representing these different terms may be found from special charts.

97. INDUCTION; HARD AND SOFT IRON.—When a piece of unmagnetized iron or steel is brought within the influence of a magnet, certain magnetic properties are immediately imparted to the former, which itself becomes magnetic and continues to remain so as long as it is within the sphere of influence of the permanent magnet; the magnetism that it acquires under these circumstances is said to be *induced*, and the properties of *induction* are such that that end or region which is nearest the pole of the influencing magnet will take up a polarity opposite thereto. If the magnet is withdrawn, the induced magnetism is soon dissipated. If the magnet is brought into proximity again, but with its opposite pole nearer, magnetism will again be induced, but this time its polarity will be reversed. A further property is that if a piece of iron or steel, while temporarily possessed of magnetic qualities through induction, be subjected to blows, twisting, or mechanical violence of any sort, the magnetism is thus made to acquire a permanent nature.

The softer the metal, from a physical point of view, the more quickly and thoroughly will induced magnetism be dissipated when the source of influence is withdrawn; hard metal, on the contrary, is slow to lose the effect of magnetism imparted to it in any way. Hence, in regarding the different features which affect deviation, it is usual to denominate as hard iron that which possesses retained magnetism of a stable nature, and as soft iron that which rapidly acquires and parts with its magnetic qualities under the varying influences to which it is subjected.

98. MAGNETIC PROPERTIES ACQUIRED BY AN IRON OR STEEL VESSEL IN BUILDING.—The inductive action of the earth's magnetism affects all iron or steel within its influence, and the amount and permanency of the magnetism so induced depends upon the position of the metal with reference to the earth's total force, upon its character, and upon the degree of hammering, bending, and twisting that it undergoes.

An iron bar held in the line of the earth's total force instantly becomes magnetic; if held at an angle thereto it would acquire magnetic properties dependent for their amount upon its inclination to the line of total force; when held at right angles to the line there would be no effect, as each extremity would be equally near the poles of the earth and all influence would be neutralized. If, while such a bar is in a magnetic state through inductive action, it should be hammered or twisted, a certain magnetism of a permanent character is impressed upon it, which is never entirely lost unless the bar is subjected to causes equal and opposite to those that produced the first effect.

A sheet of iron is affected by induction in a similar way, the magnetism induced by the earth diffusing itself over the entire plate and separating itself into regions of opposite polarity divided by a neutral area at right angles to the earth's line of total force. If the plate is hammered or bent, this magnetism takes up a permanent character.

If the magnetic mass has a third dimension, and assumes the form of a ship, a similar condition prevails. The whole takes up a magnetic character; there is a magnetic axis in the direction of the line of total force, with poles at its extremities and a zone of no magnetism perpendicular to it. The distribution of magnetism will depend upon the horizontal and vertical components of the earth's force in the locality and upon the direction of the keel in building; its permanency will depend upon the amount of mechanical violence to which the metal has been subjected by the riveting and other incidents of construction, and upon the nature of the metal employed.

99. CAUSES THAT PRODUCE DEVIATION.—There are three influences that operate to produce deviation; namely, (*a*) *subpermanent magnetism;* (*b*) *transient magnetism induced in vertical soft iron*, and (*c*) *transient magnetism induced in horizontal soft iron*. Their effect will be explained.

Subpermanent magnetism is the name given to that magnetic force which originates in the ship while building, through the process explained in the preceding article; after the vessel is launched and has an opportunity to swing in azimuth, the magnetism thus induced will suffer material diminution until, after the lapse of a certain time, it will settle down to a condition that continues practically unchanged; the magnetism that remains is denominated subpermanent. The vessel will then approximate to a permanent magnet, in which the north polarity will lie in that region which was north in building and the south polarity (that which exerts an attracting influence on the north pole of the compass needle) in the region which was south in building.

Transient magnetism induced in vertical soft iron is that developed in the soft iron of a vessel through the inductive action of the vertical component only of the earth's total force, and is transient in nature. Its value or force in any given mass varies with and depends upon the value of the vertical component at the place, and is proportional to the sine of the dip, being a maximum at the magnetic pole and zero at the magnetic equator.

Transient magnetism induced in horizontal soft iron is that developed in the soft iron of a vessel through the inductive action of the horizontal component only of the earth's total force, and is transient in nature. Its value or force in any given mass varies with and depends upon the value of the horizontal component at the place, and is proportional to the cosine of the dip, being a maximum at the magnetic equator and reducing to zero at the magnetic pole.

The needle of a compass in any position on board ship will therefore be acted upon by the earth's total force, together with the three forces just described. The poles of these forces do not usually lie in the horizontal plane of the compass needle, but as this needle is constrained to act in a horizontal plane, its movements will be affected solely by the horizontal components of these forces, and its direction will be determined by the resultant of those components.

The earth's force operates to retain the compass needle in the plane of the magnetic meridian, but the resultant of the three remaining forces, when without this plane, deflects the needle, and the amount of such deflection constitutes the deviation.

100. CLASSES OF DEVIATION.—Investigation has developed the fact that the deviation produced as described is made up of three parts, which are known respectively as *semicircular*, *quadrantal*, and *constant* deviation, the latter being the least important. A clear understanding of the nature of each of these classes is essential for a comprehension of the methods of compensation.

101. *Semicircular Deviation* is that due to the combined influence, exerted in a horizontal plane, of the subpermanent magnetism of a ship and of the magnetism induced in soft iron by the vertical component of the earth's force. If we regard the effect of these two forces as concentrated in a single resultant pole exerting an attracting influence upon the north end of the compass needle, it may be seen that there will be some heading of the ship whereon that pole will lie due north of the needle and therefore produce no deviation; now consider that, from this position, the ship's head swings in azimuth to the right; throughout all of the semicircle first described an easterly deviation will be produced, and, after completing 180°, the pole will be in a position diameterically opposite to that from which it started, and will again exert no influence that tends to produce deviation. Continuing the swing, throughout the next semicircle the direction of the deviation produced will be always to the westward, until the circle is completed and the ship returns to her original neutral position. From the fact that this disturbing cause acts in the two semicircles with equal and opposite effect it is given the name of *semicircular* deviation.

In figure 9 a curve is depicted which shows the deviations of a semicircular nature separated from those due to other disturbing causes, and from this the reason for the name will be apparent.

102. Returning to the two distinct sources from which the semicircular deviation arises, it may be seen that the force due to subpermanent magnetism remains constant regardless of the geographical position of the vessel; but since the horizontal force of the earth, which tends to hold the needle in the magnetic meridian, varies with the magnetic latitude, the deviation due to subpermanent magnetism varies inversely as the horizontal force, or as $\frac{1}{H}$; this may be readily understood if it is considered that the stronger the tendency to cling to the direction of the magnetic meridian the less will be the deflection due to a given disturbing force. On the other hand, that part of the semicircular force due to magnetism induced in vertical soft iron varies as the earth's vertical force, which is proportional to the sine of the dip; its effect in producing deviation, as in the preceding case, varies inversely as the earth's horizontal force—that is, inversely as the cosine of the dip; hence the ratio representing the change of deviation arising from this cause on change of latitude is $\frac{\sin \theta}{\cos \theta}$, or $\tan \theta$.

If, then, we consider the change in the semicircular deviation due to a change of magnetic latitude, it will be necessary to separate the two factors of the deviation and to remember that the portion produced by subpermanent magnetism varies as $\frac{1}{H}$, and that due to vertical induction as $\tan \theta$. But for any consideration of the effect of this class of deviation in one latitude only, the two parts may be joined together and regarded as having a single resultant.

103. Assuming that all the forces tending to produce semicircular deviation are concentrated in a single pole exerting an influence on the north pole of the compass, it will be seen that this can be resolved into a horizontal and a vertical component, just as the earth's magnetic force is illustrated in figure 10. It is now evident, therefore, that the horizontal component of this single magnet may be resolved into two components—one fore-and-aft, and one athwartship; in this case, the semicircular forces will be represented by two magnets, one fore-and-aft and the other athwartship, and compensation may be made by two separate magnets lying respectively in the directions stated, but with their north or repelling poles in the position occupied by the south or attracting poles of the ship's force.

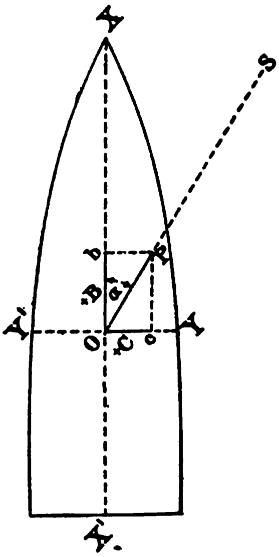

FIG. 11.

Figure 11 represents the conditions that have been described. Let O be the center of the compass, XX′ and YY′, respectively, the fore-and-aft and athwartship lines of the ship, and OS the direction in which the attracting pole of the disturbing force is exerted. Now, if OP be laid off on the line OS, representing the amount of the disturbing force according to some convenient scale, then *Ob* and *Oc*, respectively, represent, on the same scale, the resolved directions of that force in the keel line and in the transverse line of the ship. Each of these resolved forces will exert a maximum effect when acting at right angles to the needle, the athwartship one when the ship heads north or south by compass, and the longitudinal one when the heading is east or west. On any other heading than those named the deviation produced by each force will be a fraction of its maximum whose magnitude will depend upon the azimuth of the ship's head. The maximum deviation produced, therefore, forms in each case a basis for reckoning all of the various effects of the disturbing force, and is called a *coefficient*.

The coefficient of semicircular deviation produced by the force in the fore-and-aft line is called B, and is reckoned as positive when it attracts a north pole toward the bow, negative when toward the stern; that produced by the athwartship force is C, and is reckoned as positive to starboard and negative to port. These coefficients are expressed in degrees.[a]

104. The coefficient B is approximately equal to the deviation on East; or to the deviation on West with reversed sign; or to the mean of these two. Thus in the ship having the table of deviations previously given (art. 93), B is equal to $-9° 06'$, or to $-9° 56'$, or to $\frac{1}{2}(-9° 06' - 9° 56') = -9° 31'$.

The coefficient C is approximately equal to the deviation on North; or to the deviation on South with reversed sign; or to the mean of these two. In the example C is equal to $-15° 29'$, or to $-17° 52'$, or to $\frac{1}{2}(-15° 29' - 17° 52') = -16° 40'$.

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[a] It should be remarked that in a mathematical analysis of the deviations, it would be necessary to distinguish between the *approximate coefficients*, B and C, here described, as also A, D, and E, to be mentioned later, and the *exact coefficients* denoted by the corresponding capital letters of the German alphabet, which latter are in reality the *forces* producing those deviations expressed in terms of the "mean force to north" (λH), as unit. In the practical discussion of the subject here given, the question of the difference need not be entered into further.

105. The value of the subpermanent magnetism remaining practically constant under all conditions, it will not alter when the ship changes her latitude; but that due to induction in vertical soft iron undergoes a change when, by change of geographical position, the vertical component of the earth's force assumes a different value, and in such case the correction by means of one or a pair of permanent magnets will not remain effective. If, however, by series of observations in two magnetic latitudes, the values of the coefficients can be determined under the differing circumstances, it is possible, by solving equations, to determine what effect each force has in producing the semicircular deviation; having done which, the subpermanent magnetism can be corrected by permanent magnets after the method previously described, and the vertical induction in soft iron can be corrected by a piece of vertical soft iron placed in such a position near the compass as to produce an equal but opposite force to the ship's vertical soft iron. This last corrector is called a *Flinders bar.*

Having thus opposed to each of the component forces a corrector of magnetic character identical with its own, a change of latitude will make no difference in the effectiveness of the compensation, for in every case the modified conditions will produce identical results in the disturbing and in the correcting force.

106. *Quadrantal Deviation* is that which arises from horizontal induction in the soft iron of the vessel through the action of the horizontal component of the earth's total force. Let us consider, in figure 12, the effect of any piece of soft iron which is symmetrical with respect to the compass—that is, which lies wholly within a plane passing through the center of the needle in either a fore-and-aft or an athwartship direction. It may be seen (*a*) that such iron produces no deviation on the cardinal points (for on north and south headings the fore-and-aft iron, though strongly magnetized, has no tendency to draw the needle from a north-and-south line, while the athwartship iron, being at right angles to the meridian, receives no magnetic induction, and therefore exerts no force; and on east and west headings similar conditions prevail, the athwartship and the fore-and-aft iron having simply exchanged positions); and (*b*) the direction of the deviation produced is opposite in successive quadrants. The action of unsymmetrical soft iron is not quite so readily apparent, but investigation shows that part of its effect is to produce a deviation which becomes zero at the inter-cardinal points and is of opposite name in successive quadrants. From the fact that deviations of this class change sign every 90° throughout the circle, they gain the name of *quadrantal deviations.* One of the curves laid down in the Napier diagram (fig. 9) is that of quadrantal deviations, whence the nature of this disturbance of the needle may be observed.

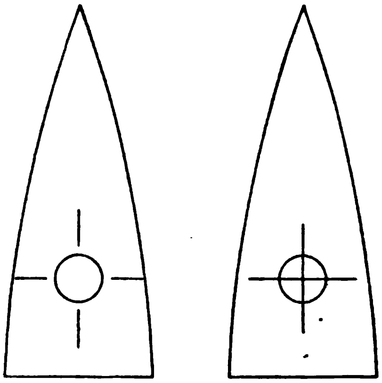
FIG. 12.

107. All deviations produced by soft iron may be considered as fractions of the maximum deviation due to that disturbing influence; and consequently the maximum is regarded as a coefficient, as in the case of semicircular deviations. The coefficient due to symmetrical soft iron is designated as D, and is considered positive when it produces easterly deviations in the quadrant between North and East; the coefficient of deviations arising from unsymmetrical soft iron is called E, and is reckoned as positive when it produces easterly deviations in the quadrant between NW. and NE.; this latter attains importance only when there is some marked inequality in the distribution of metal to starboard and to port, as in the case of a compass placed off the amidship line.

108. D is approximately equal to the mean of the deviations on NE. and SW.; or to the mean of those on SE. and NW., with sign reversed; or to the mean of those means. In the table of deviations given in article 93, D is equal to $\frac{1}{2}(-11^\circ 19' + 25^\circ 35') = +7^\circ 08'$, or to $\frac{1}{2}(+5^\circ 54' + 10^\circ 20') = +8^\circ 07'$; or to $\frac{1}{2}(7^\circ 08' + 8^\circ 07') = +7^\circ 37'$. By reason of the nature of the arrangement of iron in a ship, D is almost invariably positive.

E is approximately equal to the mean of the deviations on North and South; or to the mean of those on East and West with sign reversed; or to the mean of those means. In the example, E is equal to ½ (−15° 29′+17° 52′)=+1° 11′; or to ½ (+9° 06′−9° 56′)=−0° 25′; or to ½ (+1° 11′−0° 25′)=+0° 23′.

109. Quadrantal deviation does not, like semicircular, undergo a change upon change of magnetic latitude; being due to induction in horizontal soft iron, the magnetic force exerted to produce it is proportional to the horizontal component of the earth's magnetism; but the directive force of the needle likewise depends upon that same component; consequently, as the disturbing force exerted upon the needle increases, so does the power that holds it in the magnetic meridian, with the result that on any given heading the deflection due to soft iron is always the same.

110. Quadrantal deviation is corrected by placing masses of soft iron (usually two hollow spheres in the athwartship line, at equal distances on each side of the compass), with the center of mass in the horizontal plane of the needle. The distance is made such that the force exerted exactly counteracts that of the ship's iron. As the correcting effect of this iron will, like the directive force and the quadrantal disturbing force, vary directly with the earth's horizontal component, the compensation once properly made will be effective in all latitudes; provided that the compass needles are short and, consequently, exercise little or no induction on the quadrantal correctors.

With compasses such as the United States Navy standard 7½-inch liquid compass, the needles of which are long and powerful, it will usually be found that the position of the spheres must be changed with change of latitude. This may be accounted for by the magnetism induced in the spheres by the compass needles at the same time and in the same manner as the earth's force. In this case the quadrantal correcting force is the resultant of the constant force due to the induction of the needles in the spheres and the variable force (the earth's horizontal force, H, varying with change in magnetic latitude) due to the induction of the earth in the spheres. This resultant of these two forces is a variable force, and, after a given quadrantal deviation is corrected in one latitude by this force, the balance will be changed upon going into another latitude and the correction will fail to hold good.

In practice, the quadrantal deviation due to unsymmetrical iron is seldom corrected; the correction may be accomplished, however, by placing the soft iron masses on a line which makes an angle to the athwartship line through the center of the card.

111. *Constant Deviation* is due to induction in horizontal soft iron unsymmetrically placed about the compass. It has already been explained that one effect of such iron is to produce a quadrantal deviation, represented by one coefficient E; another effect is the *constant* deviation, so called because it is uniform in amount and direction on every heading of the ship. If plotted on a Napier diagram, it would appear as a straight line parallel with the initial line of the diagram.

112. Like other classes of deviation, the effect of the disturbing force is represented by a coefficient; this coefficient is designated as A, and is considered *plus* for easterly and *minus* for westerly errors. It is approximately equal to the mean of the deviations on any number of equidistant headings. In the case previously given, it might be found from the four headings, North, East, South, and West, and would then be equal to ¼ (−15° 29′−9° 06′+17° 52′+9° 56′)=+0° 48′; or from all of the 24 headings, when it would equal −0° 01′.

For the same reason as in the case of E, the value of A is usually so small that it may be neglected; it only attains a material size when the compass is placed off the midship line, or for some similar cause.

113. Like quadrantal deviation, since its force varies with the earth's horizontal force, the constant deviation will remain uniform in amount in all latitudes. (See art. 110.)

No attempt is made to compensate for this class of error.

114. Coefficients.—The chief value of coefficients is in mathematical analyses of the deviations and their causes. It may, however, be a convenience to the practical navigator to find their approximate values by the methods that have been given, in order that he may gain an idea of the various sources of the error, with a view to ameliorating the conditions, when necessary, by moving the binnacle or altering the surrounding iron. The following relation exists between the coefficients and the deviation:

$$d = A + B \sin z' + C \cos z' + D \sin 2z' + E \cos 2z',$$

where d is the deviation, and z' the ship's heading by compass, measured from compass North.

115. Mean Directive Force.—The effect of the disturbing forces is not confined to causing deviations; it is only those components acting at right angles to the needle which operate to produce deflection; the effect of those acting in the direction of the needle is exerted either in increasing or diminishing the directive force of the compass, according as the resolved component is northerly or southerly.

It occurs, with the usual arrangement of iron in a vessel, that the mean effect of this action throughout a complete swing of the ship upon all headings is to reduce the directive force—that is, while it varies with the heading, the average value upon all azimuths is *minus* or southerly. The result of such a condition is unfavorable from the fact that the compass is thus made more "sluggish," is easily disturbed and does not return quickly to rest, and a given deflecting force produces a greater deviation when the directive force is reduced. The usual methods of compensation largely correct this fault, but do not entirely do so; it is therefore the case that the mean combined horizontal force of earth and ship to north is generally less than the horizontal force of the earth alone; but it is only in extreme cases that this deficiency is serious.

116. Heeling Error.—This is an additional cause of deviation that arises when the vessel heels to one side or the other. Heretofore only those forces have been considered which act when the vessel is on an even keel; but if there is an inclination from the vertical certain new forces arise, and others previously inoperative become effective. These forces are (*a*) the vertical component of the subpermanent magnetism acquired in building; (*b*) the vertical component of the induced magnetism in vertical soft iron, and (*c*) the magnetism induced by the vertical component of the earth's total force in iron which, on an even keel, was horizontal. The first two of these disturbing causes are always present, but, when the ship is upright, have no tendency to produce deviation, simply exerting a downward pull on one of the poles of the needle; the last is a new force that arises when the vessel heels.

The maximum disturbance due to heel occurs when the ship heads North or South. When heading East or West there will be no deviation produced, although the directive force of the needle will be increased or diminished. The error will increase with the amount of inclination from the vertical.

117. For the same reason as was explained in connection with semicircular deviations, that part of the heeling error due to subpermanent magnetism will vary, on change of latitude, as $\frac{1}{H}$, while that due to vertical induction will vary as $\tan \theta$. In south magnetic latitude the effect of vertical induction will be opposite in direction to what it is in north latitude.

118. The heeling error is corrected by a permanent magnet placed in a vertical position directly under the center of the compass. Such a magnet has no effect upon the compass when the ship is upright; but since its force acts in an opposite direction to the force of the ship which causes heeling error, is equal to the latter in amount, and is exerted under the same conditions, it affords an effective compensation. For similar reasons to those affecting the compensation of B and C, the correction by means of a permanent magnet is not general and must be rectified upon change of latitude.

PRACTICAL COMPENSATION.

119. In the course of explanation of the different classes of deviation occasion has been taken to state generally the various methods of compensating the errors that are produced. The practical methods of applying the correctors will next be given.

120. Order of Correction.—The following is the order of steps to be followed in each case. It is assumed that the vessel is on an even keel, that the compass is properly centered in the binnacle, that all surrounding masses of iron or steel are in their normal positions, all correctors removed, and that the binnacle is one in which the semicircular deviation is corrected by two sets of permanent magnets at right angles to each other.

In order to ascertain if the compass is properly centered in the binnacle, the heeling corrector may be temporarily placed in its tube and drawn from its lowest to its highest position; if no deflection is shown by the needle the compass is properly centered; if not it should be adjusted by the screws provided for the purpose.

1. Place quadrantal correctors by estimate.
2. Correct semicircular deviation.
3. Correct quadrantal deviation.
4. Swing ship for residual deviations.

The heeling corrector may be placed at any time after the semicircular and quadrantal errors are corrected. A Flinders bar can be put in place only after observations in two latitudes.

121. The ship is first placed on some magnetic cardinal point. If North or South, the only force (theoretically speaking) which tends to produce deflection of the needle will be the athwartship component of the semicircular force, whose effect is represented by the coefficient C. If East or West, the only deflecting force will be the fore-and-aft component of the semicircular force, whose effect is represented by the coefficient B. This will be apparent from a consideration of the direction of the forces producing deviation, and is also shown by the equation connecting the terms (where A and E are zero):

$$d = \mathrm{B} \sin z' + \mathrm{C} \cos z' + \mathrm{D} \sin 2z'.$$

If the ship is headed North or South, z' being equal to 0° or 180°, the equation becomes $d = \pm \mathrm{C}$. If on East or West, z' being 90° or 270°, we have $d = \pm \mathrm{B}$.

This statement is exact if we regard only the forces that have been considered in the problem, but experience has demonstrated that the various correctors when in place create certain additional forces by their mutual action, and in order to correct the disturbances thus accidentally produced, as well as those due to regular causes, it is necessary that the magnetic conditions during correction shall approximate as closely as possible to those that exist when the compensation is completed; therefore the quadrantal correctors should first be placed on their arms at the positions which it is estimated that they will occupy later when exactly located. An error in the estimate will have but slight effect under ordinary conditions. It should be understood that the placing of these correctors has no corrective effect while the ship is on a cardinal point. Its object is to create at once the magnetic field with which we shall have to deal when compensation is perfected.

This having been done, proceed to correct the semicircular deviation. If the ship heads North or South, the force producing deflection is, as has been stated, the athwartship component of the semicircular force, which is to be corrected by permanent magnets placed athwartships; therefore enter in the binnacle one or more such magnets, and so adjust their height that the heading of the ship by compass shall agree with the magnetic heading. When this is done all the deviation on that azimuth will be corrected.

Similarly, if the ship heads East or West, the force producing deviation is the fore-and-aft component of the semicircular force, and this is to be corrected by entering fore-and-aft permanent magnets in the binnacle and adjusting the height so that the deviation on that heading disappears.

With the deviation on two adjacent cardinal points corrected, the semicircular force has been completely compensated. Next correct the quadrantal deviation. Head the ship NE., SE., SW., or NW. The coefficients B and C having been reduced to zero by compensation, and $2z'$, on the azimuths named, being equal to 90° or 270°, the equation becomes $d = \pm \mathrm{D}$. The soft-iron correctors are moved in or out from the positions in which they were placed by estimate until the deviation on the heading (all of which is due to quadrantal force) disappears. The quadrantal disturbing force is then compensated.

122. DETERMINATION OF MAGNETIC HEADINGS.—To determine when a ship is heading on any given magnetic course, and thus to know when the deviation has been corrected and the correctors are in proper position, four methods are available:

(*a*) Swing the ship and obtain by the best available method the deviations on a sufficient number of compass courses to construct a curve on the Napier diagram for one quadrant, and thus find the compass headings corresponding to two adjacent magnetic cardinal points and the intermediate intercardinal point, as North, NE., and East, magnetic.[a] Then put the ship successively on these courses, noting the corresponding headings by some other compass, and when it is desired to head on the various magnetic azimuths during the process of correction the ship may be steadied upon them by the auxiliary compass. Variations of this method will suggest themselves and circumstances may render their adoption convenient. The compass courses corresponding to the magnetic directions may be obtained from observations made with the auxiliary compass itself, or while making observations with another compass the headings by the auxiliary may be noted and a curve for the latter constructed, as explained in article 95, and the required headings thus deduced.

(*b*) By the methods to be explained hereafter (Chap. XIV), ascertain in advance the true bearing of the sun at frequent intervals during the period which is to be devoted to the compensation of the compasses; apply to these the variation and obtain the magnetic bearings; record the times and bearings in a convenient tabular form, or, better still, plot a curve of magnetic azimuths of the sun on cross section paper, the coordinates being local apparent time and magnetic bearings of the sun, as described in article 89. Set the watch accurately for the local apparent time; then when it is required to steer any given magnetic course, set that point of the pelorus for the ship's head and set the sight vanes for the magnetic bearing of the sun corresponding to the time by watch. Maneuver the ship with the helm until the sun comes on the sight vanes, when the azimuth of the ship's head will be that which is required. The sight vanes must be altered at intervals to accord with the curve or table of times and bearings.

(*c*) Construct a curve or table showing times and corresponding magnetic bearings of the sun, and also set the watch, as explained for the previous method. Then place the sight vanes of the azimuth circle of the compass at the proper angular distance to the right or left of the required azimuth of the ship's head; leave them so set and maneuver the ship with the helm until the image of the sun comes on with the vanes. The course will then be the required one. As an example, suppose that the curve or table shows that the magnetic azimuth of the sun at the time given by the watch is N. 87° E., and let it be required to head magnetic North; when placed upon this heading, therefore, the sun must bear 87° to the right or east of the direction of the ship's head; when steady on any course, turn the sight vane to the required bearing relative to the keel. If on N. 11° W., for example, turn the circle to N. 76° E.; leave the vane undisturbed and alter course until the sun comes on. The magnetic heading is then North, and adjustment may be made accordingly.

(*d*) When ranges are available, they may be utilized for determining magnetic headings.

123. SUMMARY OF ORDINARY CORRECTIONS.—To summarize, the following is the process of correcting a compass for a single latitude, where magnets at right angles are employed for compensating the semicircular deviation and where the disturbances due to unsymmetrical soft iron are small enough to be neglected.

First. All correctors being clear of the compass, place the quadrantal correctors in the position which it is estimated that they will occupy when adjustment is complete. The navigator's experience will serve in making the estimate, or if there seems no other means of arriving at the probable position they may be placed at the middle points of their supports.

Second. Steady the ship on magnetic north, east, south, or west, and hold on that heading by such method as seems best. By means of permanent magnets alter the indications of the compass until the heading coincides with the magnetic course. If heading north, magnets must be entered north ends to starboard to correct easterly deviation and to port to correct westerly, and the reverse if heading south. If heading east, enter north ends forward for easterly and aft for westerly deviations, and the reverse if heading west. (Binnacles differ so widely in the methods of carrying magnets that details on this point are omitted. It may be said, however, that the magnetic intensity of the correctors may be varied by altering either their number or their distance from the compass; generally speaking, several magnets at a distance are to be preferred to a small number close to the compass.)

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[a] This is all that is required for the purposes of compensation, but if there is opportunity it is always well to make a complete swing and obtain a full table of deviations, which may give interesting information of the existing magnetic conditions.

Third. Steady the ship on an adjacent magnetic cardinal point and correct the compass heading by permanent magnets to accord therewith in the same manner as described for the first heading.

Fourth. Steady the ship on an intercardinal point (magnetic) and move the quadrantal correctors away from or toward the compass, keeping them at equal distances therefrom, until the compass and magnetic headings coincide.

Fifth. If time permits, it is very important that the ship should next be steadied on opposite cardinal and semicardinal points and *one-half* of the remaining deviation corrected by changing the position or number of the correctors.

The compensation being complete, the navigator should proceed immediately to swing ship and make a table of the residual deviations. Though the remaining errors will be small, it is seldom that they will be reduced to zero, and it must never be assumed that the compass may be relied upon without taking the deviation into account. Observations on eight equidistant points will ordinarily suffice for this purpose.

124. Compensation of the Compass while Cruising.—Every effort should be made to keep at least the standard and steering compasses compensated, as it is always easier to keep the compasses compensated than to keep a deviation table correct, at hand, and in use.

RECTANGULAR METHOD.

By the following method the compasses may be kept practically compensated and, after the data are once obtained, it requires very little time or trouble.

After the first compensation is completed, or while it is being done, head the ship north or south and move the athwartship magnets up exactly 1 inch, noting by the bearing of the sun or of a distant object, the amount and direction of the effect on the compass. Then repeat the observation, lowering the magnets 1 inch, and noting the effect. Then head the ship east or west and take the same observations with the fore-and-aft magnets. Then head on an intercardinal point and record the effect of moving spheres first in and then out an inch from the correct position.

The record would then take this form:

Date...... Latitude...... Longitude.......

H...... θ.......

On North, raising B magnets (6 bundles) 1 inch (from 9.85 to 8.85) causes 12° 30′ Easterly deviation, therefore a movement of $\frac{1}{10}$ inch causes 1° 15′ Ely.

Lowering B magnets (6 bundles) 1 inch (from 9.85 to 10.85) causes 10° 15′ Westerly deviation, therefore a movement of $\frac{1}{10}$ inch causes 1° 2′ Wly.

On East, raising C magnet (2 bundles) 1 inch (from 10.45 to 9.45) causes 8° 15′ Westerly deviation, therefore a movement of $\frac{1}{10}$ inch causes 0° 50′ Wly.

Lowering C magnet (2 bundles) 1 inch (from 10.45 to 11.45) causes 6° 30′ Easterly deviation, therefore a movement of $\frac{1}{10}$ inch causes 0° 39′ Ely.

On Northeast, moving spheres in 1 inch (from 10.6 to 9.6) causes 4° 15′ Westerly deviation, therefore a movement of $\frac{1}{10}$ inch causes 0° 25′ Wly.

Moving spheres out 1 inch (from 10.6 to 11.6) causes 3° 20′ Easterly deviation, therefore a movement of $\frac{1}{10}$ inch causes 0° 20′ Ely.

If now it is found at any time that there is, say, 1° 45′ Easterly on East, it is evident that raising the C magnets $\frac{2}{10}$ inch will correct it, and careful observations on two adjacent cardinal points and an inter-cardinal point are enough to recompensate. This may ordinarily be done at no expense of time and with little trouble. More confidence may be felt in the result if observations for deviations are afterwards obtained on the four cardinal points and the mean of the results on opposite courses taken for the true value; this must be done if the variation is uncertain. A new set of data observations should be taken after a large change of magnetic latitude, but it will usually be found that the changes are slight.

Theoretically the quadrantal deviation, once corrected, should remain at zero. It will usually be found, however, that the position of the spheres must be changed with change of latitude. A convenient way of dealing with this is to construct a curve showing the positions of the spheres for varying values of H. A similar curve showing the position of the heeling magnet is also convenient.

Whenever the position of any corrector is changed, a note showing new position, date, latitude, longitude, H and θ should be made on one of the blank leaves of the compass record. A complete record of this kind will be found of the utmost value in keeping track of the compasses.

125. CORRECTING THE HEELING ERROR.—The heeling error may be corrected by a method involving computation, together with certain observations on shore. A more practical method, however, is usually followed, though its results may be less precise. The heeling corrector is placed in its vertical tube, N. end uppermost in north latitudes, as this is almost invariably the required direction; the ship being on a course near North or South and rolling, observe the vibrations of the card, which, if the error is material, will be in excess of those due to the ship's real motion in azimuth; slowly raise or lower the corrector until the abnormal vibrations disappear, when the correction will be made for that latitude; but it must be readjusted upon any considerable change of geographical position.

In making this observation care must be taken to distinguish the vessel's "yawing" in a seaway from the apparent motion due to heeling error; for this reason it may be well to have an assistant to watch the ship's head and keep the adjuster informed of the real change in azimuth, by which means the latter may better judge the effect of the heeling error.

In the case of a sailing vessel, or one which for any reason maintains a nearly steady heel for a continuous period, the amount of the heeling error may be exactly ascertained by observing the azimuth of the sun, and corrected with greater accuracy than is possible with a vessel which is constantly rolling.

126. FLINDERS BAR.—The simplest method that presents itself for the placing of the Flinders bar is one which is available only for a vessel crossing the magnetic equator. Magnetic charts of the world show the geographical positions at which the dip becomes zero—that is, where a freely suspended needle is exactly horizontal and where there exists no vertical component of the earth's total magnetic force. In such localities it is evident that the factor of the semicircular deviation due to vertical induction disappears and that the whole of the existing semicircular deviation arises from subpermanent magnetism. If, then, when on the magnetic equator the compass be carefully compensated, the effect of the subpermanent magnetism will be exactly opposed by that of the semicircular correcting magnets. Later, as the ship departs from the magnetic equator, the semicircular deviation will gradually acquire a material value, which will be known to be due entirely to vertical induction, and if the Flinders bar be so placed as to correct it, the compensation of the compass will be general for all latitudes.

In following this method it may usually be assumed that the soft iron of the vessel is symmetrical with respect to the fore-and-aft line and that the Flinders bar may be placed directly forward of the compass or directly abaft it, disregarding the effect of components to starboard or port. It is therefore merely necessary to observe whether a vertical soft iron rod must be placed forward or abaft the compass to reduce the deviation, and, having ascertained this fact, to find by experiment the exact distance at which it completely corrects the deviation.

The Flinders bar frequently consists of a bundle of soft iron rods contained in a case, which is secured in a vertical position near the compass, its upper end level with the plane of the needles; in this method, the distance remaining fixed, the intensity of the force that it exerts is varied by increasing or decreasing the number of rods; this arrangement is more convenient and satisfactory than the employment of a single rod at a variable distance.

The United States Navy Flinders bar, Type II, is made of carefully annealed pure soft iron, 2 inches in diameter, total length 24 inches, consisting of pieces 12 inches, 6 inches, 3 inches, 1½ inches, and ¾ inch (2 of these) long. Hardwood blocks of the same dimensions are used to support the proper length of Flinders bar at the top of a fixed brass tube, which is secured ordinarily at the forward end of the binnacle in the fore-and-aft line.

It should be noted, however, that it is extremely difficult to get soft iron rods of a satisfactory quality, for, after being placed, they seldom fail to take up more or less subpermanent magnetism. This magnetism, due to shock of gunfire, vibration while cruising or on speed trials, etc., is subject to greater and more erratic changes than that of the harder portion of the hull, and its proximity to the compass intensifies the effect of the variations in its magnetic properties.

127. When it is not possible to correct the compass at the magnetic equator there is no ready practical method by which the Flinders bar may be placed; the operation will then depend entirely upon computation, and as a mathematical analysis of deviations is beyond the scope laid out for this work the details of procedure will not be gone into; the general principles involved are indicated, and students seeking more must consult the various works that treat the subject fully.

It has been explained that each coefficient of semicircular deviation (B and C) is made up of a subpermanent factor varying as $\frac{1}{H}$ and of a vertical induction factor varying as $\tan \theta$. If we indicate by the subscripts $_s$ and $_v$, respectively, the parts due to each force, we may write the equations of the coefficients:

$$B = B_s \times \frac{1}{H} + B_v \times \tan \theta; \text{ and}$$

$$C = C_s \times \frac{1}{H} + C_v \times \tan \theta.$$

Now if we distinguish by the subscripts $_1$ and $_2$ the values in the first and in the second position of observation, respectively, of those quantities that vary with the magnetic latitude, we have:

$$B_1 = B_s \times \frac{1}{H_1} + B_v \times \tan \theta_1,$$

$$B_2 = B_s \times \frac{1}{H_2} + B_v \times \tan \theta_2; \text{ and}$$

$$C_1 = C_s \times \frac{1}{H_1} + C_v \times \tan \theta_1,$$

$$C_2 = C_s \times \frac{1}{H_2} + C_v \times \tan \theta_2.$$

The values of the coefficients in both latitudes are found from the observations made for deviations; the values of the horizontal force and of the dip at each place are known from magnetic charts; hence we may solve the first pair of equations for B_s and B_v, and the second pair for C_s and C_v; and having found the values of these various coefficients, we may correct the effects of B_s and C_s by permanent magnets in the usual way and correct the remainder—that due to B_v and C_v—by the Flinders bar.

Strictly, the Flinders bar should be so placed that its repelling pole is at an angular distance from ahead equal to the "starboard angle" of the attracting pole of the vertical induced force, this angle depending upon the coefficients B_v and C_v; but since, as before stated, horizontal soft iron may usually be regarded as symmetrical, C_v is assumed as zero and the bar placed in the midship line.

128. TO CORRECT ADJUSTMENT ON CHANGE OF LATITUDE.—The compensation of quadrantal deviation, once properly made, remains effective in all latitudes, excepting as noted in article 110; but unless a Flinders bar is used a correction of the semicircular deviation made in one latitude will not remain accurate when the vessel has materially changed her position on the earth's surface. With this in mind the navigator must make frequent observations of the compass error during a passage and must expect that the table of residual deviations obtained in the magnetic latitude of compensation will undergo considerable change as that latitude is departed from. The new deviations may become so large that it will be found convenient to readjust the semicircular correcting magnets. This process is very simple.

When correctors at right angles are used, provide for steadying the ship, by an auxiliary compass or by the pelorus, upon two adjacent magnetic cardinal points (art. 122). Put the ship on heading North or South (magnetic), and raise or lower the athwartship magnets or alter their number until the deviation disappears; then steady on East or West (magnetic) and similarly adjust the fore-and-aft magnets. Swing ship for a new table of residual deviations.

129. It must be borne in mind that the compensation of the compass is not an exact science and that the only safeguard is unceasing watchfulness on the navigator's part. As the ship's iron is partly "hard" and partly "soft," the subpermanent magnetism may change appreciably from day to day, especially in a new ship as the magnetism absorbed in building "shakes out." After a ship has been in service for one or two years, the magnetic conditions may be said to be "settled." They undergo changes, however, to a greater or less extent, on account of the following influences or conditions:

(*a*) Continuous steaming on one general course for several days, especially in rough weather, or lying alongside a dock on one heading for a long period.

(*b*) Shock of gunfire, even on a ship that has been in commission for more than a year, has been known to introduce an 8° error, which disappeared in the course of a few days.

(*c*) Extensive alterations or repairs in the vicinity of the compass. The use of scaling hammers on a military top caused a 3° change in one of the U. S. S. *Connecticut's* compasses.

(*d*) Steaming with boilers (especially under forced draft) whose funnel is near the compass has been known to cause a change of more than 10°, the retained magnetism being "cooked out."

(*e*) On the U. S. S. *Oregon*, a grounded searchlight circuit caused a change of 9°.

(*f*) Ships have reported changes of as much as 7° when struck by lightning or after passing through very severe thunderstorms.

The binnacle fittings must be carefully inspected from time to time, to see that the correctors have not changed position. At least once a year the quadrantal correctors should be examined for polarity. This can be done by moving them, one at a time, as close to the compass as practicable and then revolving them slowly about the vertical axis; if the compass is deflected, the magnetism should be removed by bringing the sphere to a low red heat and then letting it cool slowly.

There is no excuse for large deviations in a standard or steering compass, and they should not be allowed to exist.

CHAPTER IV.

PILOTING.

130. *Piloting*, in the sense given the word by modern and popular usage, is the art of conducting a vessel in channels and harbors and along coasts, where landmarks and aids to navigation are available for fixing the position, and where the depth of water and dangers to navigation are such as to require a constant watch to be kept upon the vessel's course and frequent changes to be made therein.

Piloting is the most important part of navigation and the part requiring the most experience and nicest judgment. An error in position on the high seas may be rectified by later observation, but an error in position while piloting usually results in disaster. Therefore the navigator should make every effort to be proficient in this important branch, bearing in mind that a modern vessel is usually safe on the high seas and in danger when approaching the land and making the harbor.

131. *Requisites.*—The navigator should have ready on approaching the land the charts of the coast and the largest scale detail charts of the locality at which he expects to make his landfall, the sailing directions, and the light and buoy list, all corrected for the latest information from the Notices to Mariners and other sources. The usual instruments employed in navigation should be at hand and in good working order. The most important instrument—the sounding machine—should be in place and in order at least a day before the land is to be made. *The importance of the sounding machine can not be exaggerated.* The latest deviation table for the standard compass must be at hand.

132. LAYING THE COURSE.—Mark a point upon the chart at the ship's position; then mark another point for which it is desired to steer; join the two by a line drawn with the parallel ruler, and, maintaining the direction of the line, move the ruler until its edge passes through the center of the compass rose and note the direction. If the compass rose indicates *true* directions, this will be the true course; and must be corrected for variation and deviation (by applying each in the *opposite* direction to its name) to obtain the compass course; if it is a *magnetic* rose, the course need be corrected for deviation only.

Before putting the ship on any course a careful look should be taken along the line over which it leads to be assured that it clears all dangers.

133. METHODS OF FIXING POSITION.—A navigator in sight of objects whose positions are shown upon the chart may locate his vessel by any one of the following methods: (*a*) cross bearings of two known objects; (*b*) the bearing and distance of a known object; (*c*) the bearing of a known object and the angle between two known objects; (*d*) two bearings of a known object separated by an interval of time, with the run during that interval; (*e*) sextant angles between three known objects. Besides the foregoing there are two methods by which, without obtaining the precise position, the navigator may assure himself that he is clear of any particular danger. These are: (*f*) the danger angle; (*g*) the danger bearing.

The choice of the method will be governed by circumstances, depending upon which is best adapted to prevailing conditions.

134. CROSS BEARINGS OF TWO KNOWN OBJECTS.—Choose two objects whose position on the chart can be unmistakably identified and whose respective bearings from the ship differ, as nearly as possible by 90°; observe the bearing of each, either by compass or pelorus, taking one as quickly as possible after the other; see that the ship is on an even keel at the time the observation is made, and, if using the pelorus, be sure also that she heads exactly on the course for which the pelorus is set. Correct the bearings so that they will be either true or magnetic, according as they are to be plotted by the true or magnetic compass rose of the chart—that is, if observed by compass, apply deviation and variation to obtain the true bearing, or deviation only to obtain the magnetic; if observed by pelorus, that instrument should be set for the true or magnetic heading, according as one or the other sort of reading is required, and no further correction will be necessary. Draw on the chart, by means of the parallel rulers, lines which shall pass through the respective objects in the direction that each was observed to bear. As the ship's position on the chart is known to be at some point of each of these lines, it must be at their intersection, the only point that fulfills both conditions.

In figure 13, if A and B are the objects and OA and OB the lines passing through them in the observed directions, the ship's position will be at O, their intersection.

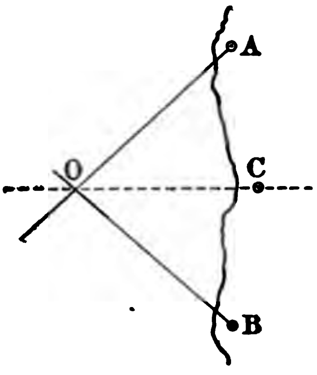

FIG. 13.

The plotting of a position from two bearings is greatly facilitated by the use of a plotter devised by Lieut. R. A. Koch, United States Navy, as reference to the compass rose on the chart, the use of parallel rulers, and the drawing of lines on the chart are obviated. A brief description of this plotter and its uses is as follows: All materials except bolt and washers are transparent. A square (7 by 7 inches) ruled with two series of lines at right angles about one-half inch apart, and a disk (7½ inches in diameter) marked in degrees are placed on a central hollow bolt of brass and are capable of being clamped together with any degree of friction required. Three arms are placed so as to revolve around the same hollow bolt and can be clamped together in any position. In order to plot a position from compass bearings of two objects, and lay off a new course, the zero mark of the disk should be revolved to the East or West of the true North and South line of the square by an amount equal to the compass error in degrees. Two of the arms are then set by the degrees on the disk to the two observed compass bearings. The plotter is then manipulated on the chart until the two arms intersect the objects observed and the vertical lines on the square are parallel to the meridians of the chart. Mark the point of intersection of the arms by inserting a pencil in the hollow central bolt. An arm may then be swung to intersect any object on the chart and the compass course to that object read from the disk. This plotter can also be used to obtain the error of the compass from bearings of three objects by compass.

135. If it be possible to avoid it, objects should not be selected for cross bearings which subtend an angle at the ship of less than 30° or more than 150°, as, when the lines of bearing approach parallelism, a small error in an observed bearing gives a large error in the result. For a similar reason objects near the ship should be taken in preference to those at a distance.

136. When a third object is available a bearing of that may be taken and plotted. If this line intersects at the same point as the other two (as the bearing OC of the object C in the figure), the navigator may have a reasonable assurance that his "fix" is correct; if it does not, it indicates an error somewhere, and it may have arisen from inaccurate observation, incorrect determination or application of the deviation, or a fault in the chart.

137. What may be considered as a form of this method can be used when only one known object is in sight by taking, at the same instant as the bearing, an altitude of the sun or other heavenly body and noting the time; work out the sight and obtain the Sumner line (as explained in Chapter XV), and the intersection of this with the direction line from the object will give the observer's position in the same way as from two terrestrial bearings.

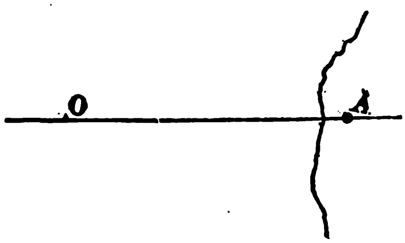

FIG. 14.

138. BEARING AND DISTANCE OF A KNOWN OBJECT.—When only one object is available, the ship's position may be found by observing its bearing and distance. Follow the preceding method in the manner of taking, correcting, and plotting the bearing; then, on this line, lay off the distance from the object, which will give the point occupied by the observer. In figure 14, if A represents the object and AO the bearing and distance, the position sought will be at O.

The stadimeter is an instrument, similar to a sextant, employed in the United States Navy, reading directly the distance of the object observed when set for the height of the object.

Range-finding instruments are used in the United States Navy for readily finding the distance of an observed object, and these instruments do not require knowledge of the height of the object. These instruments are accurate for navigational purposes up to ten thousand yards.

139. It is not ordinarily easy to find directly the distance of an object at sea. The most accurate method is when its height is known and it subtends a fair-sized angle from the ship, in which case the angle may be measured by a sextant[a] and the distance computed or taken from a table. Table 33 of this work gives distances up to 5 miles, corresponding to various heights and angles. Captain Lecky's "Danger Angle and Offshore Distance Tables" carries the computation much further. The use of this method at great distances must not be too closely relied upon, as small errors, such as those due to refraction, may throw out the results to a material extent, but it affords an excellent approximation; and, as this method of fixing position is employed only when no other is available, the best possible approximation has to suffice.

In measuring vertical angles, strictness requires that the observation should be so made that the angle at the foot of the object should equal 90° and that the triangle be a right triangle, as OMN, figure 15, where the line OM is truly horizontal, and not as in the triangle O′MN, where the condition is not fulfilled. This error is inappreciable, however, save at very close distances, when it may be sufficiently corrected by getting down as low as possible on board the vessel, so that the eye is near the water line. One condition exists, however, where the error is material—that shown in figure 16, where the visible shore line is at M′, a considerable distance from M, the point vertically below the summit. In this case there is nothing to mark M in the observer's eye, and it is essential that all angles be measured from a point close down to the water line.

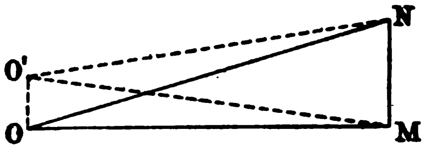

FIG. 15.

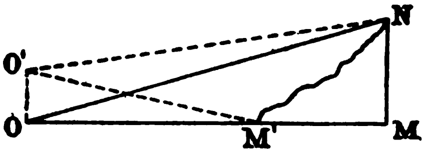

FIG. 16.

If a choice of objects can be made, the best results will be obtained by observing that one which subtends the greatest angle, as small errors will then have the least effect.

140. There is another method, known as Buckner's method, for determining the distance of an object, which is available under certain circumstances. This consists in observing, from a position aloft, the angle between the object and the line of the sea horizon beyond. By reference to Table 34 will be found the distance in yards corresponding to different angles for various heights of the observer from 20 to 120 feet. The method is not accurate beyond moderate distances (the table being limited to 5,000 yards) and is obviously only available for finding the distance of an isolated object, such as an islet, vessel, or target, over which the horizon may be seen. In employing this method the higher the position occupied by the observer the more precise will be the results.

141. In observing small angles, such as those that occur in the methods just described, it is sometimes convenient to measure them *on and off* the limb of the sextant. First look at the bottom of the object and reflect the top down into coincidence; then look through the transparent part of the horizon glass at the top and bring the bottom up by its reflected ray. The mean of the two readings will be the true angle, the index correction having been eliminated by the operation.

142. When the methods of finding distance by a vertical or a horizon angle are not available, it must be obtained by such means as exist. Estimate the distance by the appearance; take a sounding, and note where the depth falls upon the line of bearing; at night, if atmospheric conditions are normal, consider that the distance of a light when sighted is equal to its maximum range of visibility, remembering that its range is stated for a height of eye of 15 feet; or employ such method as suggests itself under the circumstances, regarding the result, however, as an approximation only.

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[a] The use of the sextant is explained in Chapter VIII.

143. The Bearing of a Known Object and the Angle between Two Known Objects.—This method is seldom employed, as the conditions always permit of cross bearings being taken, and the latter is generally considered preferable.

Take a bearing of a known object by compass or pelorus and observe the sextant angle between some two known objects. The line of bearing is plotted as in former methods. In case one of the objects of the observed angle is that whose bearing is taken, the angle is applied, right or left as the case may be, to the bearing; thus giving the direction of the second object, which is plotted from the compass rose and parallel rulers. If the object whose bearing is taken is not one of the objects of the angle, lay off the angle on a three-armed protractor, or piece of tracing paper, and swing it (keeping the legs or lines always over the two objects) until it passes over the line of bearing, which defines the position of the ship; there will, except in special cases, be two points of intersection of the line with the circle thus described, and the navigator must know his position with sufficient closeness to judge which is correct.

144. Two Bearings of a Known Object.—This is a most useful method, which is frequently employed, certain special cases arising thereunder being particularly easy of application. The process is to take a careful bearing and at the same moment read the patent log; then, after running a convenient distance, take a second bearing and again read the log, the difference in readings giving the intervening run; when running at a known speed, the time interval will also afford a means for determining the distance run.

The problem is as follows: In figure 17, given OA, the direction of a known object, A, at the first observation; PA, the direction at the second observation; and OP, the distance traversed between the two; to find AP, the distance at the second observation.

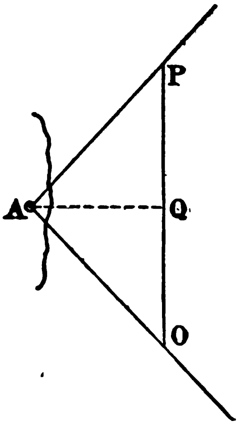

Fig. 17.

Knowing the angle POA, the angular distance of the object from right ahead at the first bearing; OPA, the angular distance from right astern at the second bearing; and OP, the distance run; we have by Plane Trigonometry:

$$PAO = 180° - (POA + OPA); \text{ and}$$
$$AP = OP \times \frac{\sin POA}{\sin PAO}.$$

If, as is frequently the case, we desire to know the distance of passing abeam, we have:

$$AQ = AP \times \sin OPA.$$

Tables 5A and 5B give solutions for this problem, the former for intervals of bearing of quarter points, the latter for intervals of two degrees. The first column of each of these tables gives the value of AP, the distance of the ship from the observed object at the time of taking the last bearing, for values of OP equal to unity; that is, for a run between bearings of 1 mile. The second column gives AQ, the distance of the object when it bears abeam, likewise for a value of OP of 1 mile. When the run between bearings is other than 1 mile, the number taken from the table must be used as a multiplier of that run to give the required distance.

Example: A vessel steering north takes a bearing of a light NW. ½ W.; then runs 4.3 miles, when the bearing is found to be WSW. Required the distance of the light at the time of the second bearing.

Difference between course and first bearing, 4½ pts.
Difference between course and second bearing, 10 pts.
Multiplier from first column, Table 5A, 0.88.
4.3 miles × 0.88 = 3.8 miles, distance at second bearing.

Example: A vessel on a course 128° takes the first bearing of an object at 154°, and the second at 182°, running in the interval 0.8 mile. Required the distance at which she will pass abeam.

Difference between course and first bearing, 26°
Difference between course and second bearing, 54°.
Multiplier from second column, Table 5B, 0.76.
0.8 mile × 0.76 = 0.6 mile, distance of passing abeam.

145. As has been said, there are certain special cases of this problem where it is exceptionally easy of application; these arise when the multiplier is equal to unity and the distance run is therefore equal to the distance from the object. When the angular distance on the bow at the second bearing is twice as great as it was at the first bearing, the distance of the object from the ship *at second bearing* is equal to the run, the multiplier being 1.0. For if, in figure 18, when the ship is in the first position, O, the object A bears $\alpha°$ on the bow, and at the second position, P, $2\alpha°$, we have in the triangle APO, observing that $APO = 180° - 2\alpha$, and $POA = \alpha$:

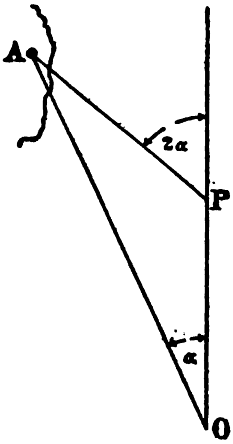

FIG. 18.

$$\begin{aligned} PAO &= 180° - (POA + APO), \\ &= 180° - (\alpha + 180° - 2\alpha), \\ &= \alpha. \end{aligned}$$

Or, since the angles at O and A are equal to each other, the sides OP and AP are equal or the distance at second bearing is equal to the run. This is known as *doubling the angle on the bow.*

146. A case where this holds good is familiar to every navigator as the *bow and beam bearing*, where the first bearing is taken when the object is broad on the bow (four points or 45° from ahead) and the second when it is abeam (eight points or 90° from ahead); in that case the distance at second bearing and the distance abeam are identical and equal to the run between bearings.

147. When the first bearing is 26½° from ahead, and the second 45°, the distance *at which the object will be passed abeam* will equal the run between bearings. This is true of any two such bearings whose natural cotangents differ by unity, and the following table is a collection of solutions of this relation in which the pairs of bearings are such that, when observed in succession from ahead upon the same fixed object, the distance run between the bearings will be equal to the distance of the fixed object when it bears abeam, provided that a steady course has been steered, unaffected by current or drift.

The marked pairs will probably be found the most convenient ones to use, as they involve whole degrees only.

Bearings from ahead.

First.	Second.	First.	Second.	First.	Second.
°	°	°	°	°	°
20	29¾	28	48½	37	71¾
21	31¾	*29	51	38	74¼
*22	34	30	53¾	39	76¾
23	36½	31	56½	*40	79
24	38¾	*32	59	41	81½
*25	41	33	61½	42	83½
26	43½	34	64¼	43	85¾
26½	45	35	66¾	*44	88
*27	46	36	69½	*45	90

When the fixed object bears as per any entry of the first column, take the time and the reading of the patent log. Repeat this procedure on reaching the bearing of the adjacent entry in the second column. The difference of the patent-log readings will be the distance at which the fixed object will be passed abeam.

This general solution includes the 26½°–45° rule as well as the seven-tenths rule to be explained later; furthermore, it has the advantage that the approximate determination of the distance offshore, at which the fixed object will be passed, need not wait for the 45° bearing. There are two whole-degree pairs by which such a determination can be made before the 45° bearing is reached. It is possible to get five whole-degree bearings or observations by the time the fixed object bears 30° forward of the beam, as follows: 22°–34°, 25°–41°, 27°–46°, 29°–51°, 32°–59°. Of these, the last three should be reasonably accurate; the acuteness of the first angle in all such observations accounts for the discrepancies noted in practice. The use of the table given above may be found to be more convenient than the methods of plotting about to be described, and the use of tables 5A and 5B; but it does not take the place of those methods. Tables 5A and 5B cover all combinations of bearings in which the first bearing is taken when the object is 20° or more on the bow.

The Seven-tenths Rule.—If bearings of the fixed object be taken at two (2) and four (4) points on the bow (22½° and 45°), seven-tenths (0.7) of the run between bearings will be the distance at which the point will be passed abeam.

From the combination of the seven-tenths rule and the 26½°–45° rule, there follows an interesting corollary, i. e., if bearings of an object at 22½° and 26½° on the bow be taken, then seven-thirds ($\frac{7}{3}$) of the distance run in the interval will be the distance when abeam.

If a bearing is taken when an object is two points (22½°) forward of the beam and the run until it bears abeam is measured, then its distance when abeam is seven-thirds ($\frac{7}{3}$) of the run. This rule, particularly, is only approximate.

In case the 45° bearing on the bow is lost, in order to find the distance abeam that the object is passed, note the time when the object bears 26½° forward of the beam, and again when it has the same bearing abaft the beam; the distance run in this interval is the distance of the object when it was abeam.

To steer an arc course in order to round a light, point, or other object without fixes and be sure the course itself does not decrease the initial distance: Provided there is no current, stand on course until the light is at the required distance, determined by one or more of the methods described. Immediately bring the light abeam, and do not let it get forward of the beam again, then the course will not decrease the initial distance. When the light is one-half point abaft the beam again bring it abeam; hold course until it is again one-half point abaft the beam, repeating this procedure until the light is rounded. A polygon is thus circumscribed about the circle, the nearest approach to the light being the radius of the inscribed circle. The number of sides of the polygon may be increased indefinitely, so that the light may be rounded, by changing the course just enough to keep the light abeam, after it is first brought abeam.

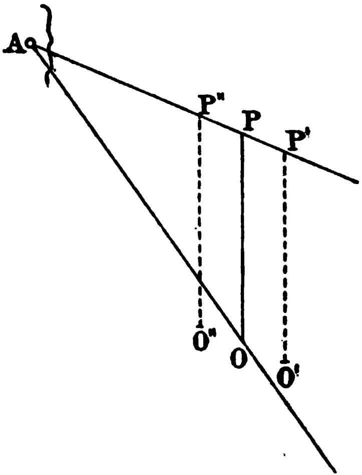

FIG. 19.

148. There is a *graphic method* of solving this problem that is considered by some more convenient than the use of multipliers. Draw upon the chart the lines OA and PA (fig. 19), passing through the object on the two observed bearings; set the dividers to the distance run, OP; lay down the parallel rulers in a direction parallel to the course and move them toward or away from the observed object until some point is found where the distance between the lines of bearing is exactly equal to the distance between the points of the dividers; in the figure this occurs when the rulers lie along the line OP, and therefore O represents the position of the ship at the first bearing and P at the second. For any other positions O′P′, O″P″, the condition is not fulfilled.

149. Another graphic solution is given by the Mooring and Maneuvering Board and the various modifications of it that are in use among navigators.

150. The method of obtaining position by two bearings of the same object is one of great value, by reason of the fact that it is frequently necessary to locate the ship when there is but one landmark in sight. Careful navigators seldom, if ever, miss the opportunity for a bow and beam bearing in passing a lighthouse or other well-plotted object; it involves little or no trouble, and always gives a feeling of added security, however little the position may be in doubt. If about to pass an object abreast of which there is a danger—a familiar example of which is when a lighthouse marks a point off which are rocks or shoals—a good assurance of clearance should be obtained before bringing it abeam, either by doubling the angle on the bow, or, if the object be sighted in time, by using any of the pairs of bearings tabulated under article 147.

151. It must be remembered that, however convenient, the fix obtained by two bearings of the same object will be in error unless the course and distance are correctly estimated, the course "made good" and the distance "over the ground" being required. Difficulty will occur in estimating the exact course when there is bad steering, a cross current, or when a ship is making leeway; errors in the allowed run will arise when she is being set ahead or back by a current or when the logging is inaccurate. A current directly with the course of the ship, if unallowed for, will give a determination of position too close to the object observed; and a current directly against the course of the ship, if unallowed for, will give a determination of position too far away from the object observed. The existence of such a current *will not be* revealed by taking more than two successive bearings. All such observations will place the ship on the same apparent course, which course will be parallel to the course made good and to the course steered but in error in its distance from the observed object by an amount dependent upon the ratio of the speed of ship over ground to the speed of ship by log. A current oblique to the course of the ship will give a determination of position which will be erroneous. The existence of such a current but not its amount *will be* revealed by taking more than two observations; in this case, following the usual method of plotting, the determination resulting from any two successive bearings will fail to agree with the determination from any other two. If, in such a case, the observed bearings be drawn upon the chart and the distances run by log between them be laid down on the scale of the chart upon a piece of paper, a course may be found by trial, upon which course the intervals of run correspond with the intervals between the lines of bearing. The apparent course thus determined, which must always be oblique to the course steered, will be parallel to the course actually being made good, but will be in error in its distance from the observed object by an amount dependent upon the ratio of the speed of ship over the ground to the speed of ship by log. If there is an apparant shortening of the distance run from earlier to later observations, or a shortening of the time if the speed is invariable, there is a component of set toward the fixed object. Therefore, if in a current of any sort, due allowance must be made, and it should be remembered that more dependence can be placed upon a position fixed by simultaneous bearings or angles, when two or more objects are available, than by two bearings of a single object.

152. SEXTANT ANGLES BETWEEN THREE KNOWN OBJECTS.—This method, involving the solution of the *three-point problem*, will, if the objects be well chosen, give the most accurate results of any. It is largely employed in surveying, because of its precision; and it is especially valuable in navigation, because it is not subject to errors arising from imperfect knowledge of the compass error, improper logging, or the effects of current, as are the methods previously described.

Three objects represented on the chart are selected and the angles measured with sextants of known index error between the center one and each of the others. Preferably there should be two observers and the two angles be taken simultaneously, but one observer may first take the angle which is changing more slowly, then take the other, then repeat the first angle, and consider the mean of the first and last observations as the value of the first angle. The position is usually plotted by means of the three-armed protractor, or station-pointer (see art. 428, Chap. XVII). Set the right and left angles on the instrument, and then move it over the chart until the three beveled edges pass respectively and simultaneously through the three objects. The center of the instrument will then mark the ship's position, which may be pricked on the chart or marked with a pencil point through the center hole. When the three-armed protractor is not at hand, the tracing-paper protractor will prove an excellent substitute, and may in some cases be preferable to it, as, for instance, when the objects angled on are so near the observer as to be hidden by the circle of the instrument. A graduated circle printed upon tracing paper permits the angles being readily laid off, but a plain piece of tracing paper may be used and the angles marked by means of a small protractor. The tracing-paper protractor permits the laying down, for simultaneous trial, of a number of angles, where special accuracy is sought.

153. The three-point problem, by which results are obtained in this method, is: To find a point such that three lines drawn from this point to three given points shall make given angles with each other.

Let A, B, and C, in figure 20, be three fixed objects on shore, and from the ship, at D, suppose the angles CDB and ADB are found equal, respectively, to 40° and 60°.

With the complement of CDB, 50°, draw the lines BE and CE; the point of intersection will be the center of a circle, on some point of whose circumference the ship must be. Then, with the complement of the angle ADB, 30°, draw the lines AF and BF, meeting at F, which point will be the center of another circle, on some point of whose circumference the ship must be. Then D, the point of intersection of the circumference of the two circles, will be the position of the ship.

The correctness of this solution may be seen as follows: Take the first circle, DBC; in the triangle EBC, the angle at E, the center, equals $180° - 2 \times 50° = 2\ (90° - 50°)$, twice the complement of 50°, which is twice the observed angle; now if the angle at the center subtended by the chord BC equals twice the observed angle, then the angle at any point on the circumference subtended by that chord, which equals half the angle at the center, equals the observed angle; so the required condition is fulfilled. Should either of the angles exceed 90°, the excess of the angle over 90° must be laid off on the opposite side of the lines joining the stations.

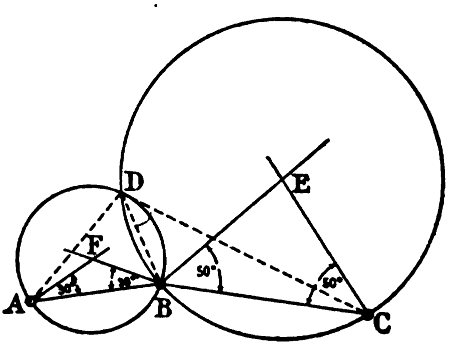

FIG. 20.

It may be seen that the intersection of the circles becomes less sharp as the centers E and F approach each other; and finally that the problem becomes indeterminate when the centers coincide, that is, when the three observed points and the observer's position all fall upon the same circle; the two circles are then identical and there is no intersection; such a case is called a "revolver," because the protractor will revolve around the whole circle, everywhere passing through the observed points. The avoidance of the revolver and the employment of large angles and short distances form the keys to the selection of favorable objects.

Generally speaking, the observer, in judging which objects are the best to be taken, can picture in his eye the circle passing through the three points and note whether it comes near to his own position. If it does, he must reject one or more of the objects for another or others. It should be remembered that he must avoid not only the condition where the circle passes exactly through his position (when the problem is wholly indeterminate), but also all conditions approximating thereto, for in such cases the circles will intersect at a very acute angle, and the inevitable small errors of the observation and plotting will produce large errors in the resulting fix.

Without giving an analysis of reasons, which may be found in various works that treat the problem in detail, the following may be enumerated as the general conditions which result in a *good* fix:

(*a*) When the center object of the three lies between the observer and a line joining the other two, or lies nearer than either of the other two.

(*b*) When the sum of the right and left angles is equal to or greater than 180°.

(*c*) When two of the objects are in range, or nearly so, and the angle to the third is not less than 30°.

(*d*) When the three objects are in the same straight line.

A condition that limits all of these is that angles should be large—at least as large as 30°—excepting in the case where two objects are in range or nearly so, and then the other angle must be of good size. When possible, near objects should be used rather than distant ones. The navigator should not fall into the error of assuming that objects which would give good cuts for a cross bearing are necessarily favorable for the three-point solution.

In a revolver, the angle formed by lines drawn from the center object to the other two, added to the sum of the two observed angles, equals 180°. A knowledge of this fact may aid in the choice of objects.

If in doubt as to the accuracy with which the angles will plot, a third angle to a fourth object may be taken. Another way to make sure of a doubtful fix is to take one compass bearing, by means of which even a revolver may be made to give a good position.

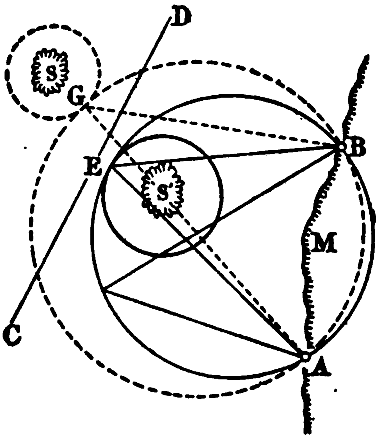

Fig. 21.

154. The Danger Angle.—When sailing along a coast, to avoid sunken rocks, or shoals, or dangerous obstructions at or below the surface of the water, and which are marked on the chart, the navigator may pass these at any desired distance by using what is known as a *danger angle*, of which there are two kinds, namely, the horizontal and vertical danger angles; the former requires two well-marked objects indicated on the chart, lying in the direction of the coast, and sufficiently distant from each other to give a fair-sized horizontal angle; the latter requires a well-charted object of known height.

155. In figure 21, let AMB be a portion of the coast along which a vessel is sailing on the course CD; A and B two prominent objects shown on the chart; S and S′ are two outlying shoals, reefs, or dangers. In order to pass outside of the danger S′ take the middle point of the danger as a center and the given distance from the center it is desired to pass as radius, and describe a circle. Pass a circle through A and B tangent to the seaward side of the first circle. To do this, it is only necessary to join A and B and draw a line perpendicular to the middle of AB, and then ascertain by trial the location of the center of the circle EAB. Measure the angle AEB, set the sextant to this angle, and remembering that AB subtends the same angle at all points of the arc AEB, the ship will be outside the arc AEB, and clear the danger S′, as long as AB does not subtend an angle greater than AEB, to which the sextant is set. At the same time in order to avoid the danger S, take the middle point of the danger S and with the desired distance as a radius describe a circle. Pass a second circle through A and B tangent to this circle at G, measure the angle AGB with a protractor, then, as long as the chord AB subtends an angle greater than AGB, the ship will be inside the circle AGB. Therefore, the ship will pass between the dangers S and S′ as long as the angle subtended by AB is less than AEB and greater than AGB.

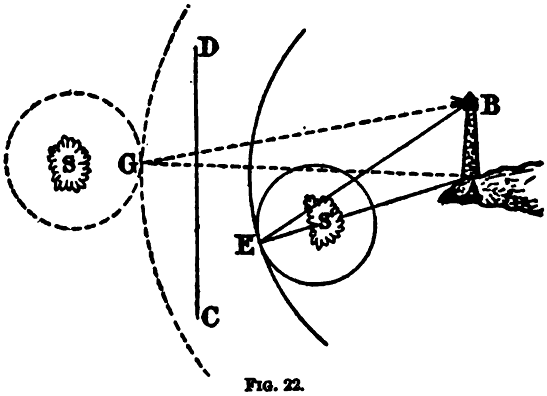

Fig. 22.

156. The vertical danger angle involves the same general principle, as can be readily seen without explanation by reference to the figure 22 in which AB represents a vertical object of known height.

157. The Danger Bearing.—This is a method by which the navigator is warned by a compass bearing when the course is leading into danger. Suppose a vessel to be steering a course, as indicated in figure 23, along a coast which must not be approached within a certain distance, the landmark A being a guide. Let the navigator draw through A the line XA, clear of the danger at all points, and note its direction by the compass rose; then let frequent bearings be taken as the ship proceeds, and so long as the bearings, YA, ZA, are to the *right* of XA he may be assured that he is on the *left* or safe side of the line.

If, as in the case given, there is but one object in sight and that nearly ahead, it would be very difficult to get an exact position, but this method would always show whether or not the ship was on a good course, and would, in consequence, be of the greatest value. And even if there were other objects visible by which to get an accurate fix it would be a more simple matter to note, by an occasional glance over the sightvane of the pelorus or compass, that the ship was making good a safe course than to be put to the necessity of plotting the position each time.

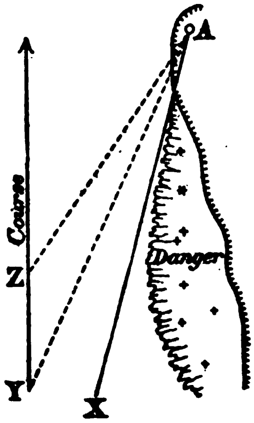

Fig. 23.

158. It will occasionally occur that two natural objects will so lie that when in range they mark a danger bearing; advantage should be taken of all such, as they are easier to observe than a compass bearing; but if in a locality with which the navigator has not had previous acquaintance the compass bearing of all ranges should be observed and compared with that indicated on the chart in order to make sure of the identity of the objects. The utility of ranges, either artificial or natural, as guides in navigation, extends also to established lines of bearing giving the true or magnetic direction of fixed objects, such as lines of bearing limiting the sectors of navigational lights.

159. Soundings.—The practice should be followed of employing one or two leadsmen to take and report soundings continuously while in shoal water or in the vicinity of dangers. The soundings must not be regarded as fixing a position, but they afford a check upon the positions obtained by other methods. An exact agreement with the soundings on the chart need not be expected, as there may be some little inaccuracies in reporting the depth on a ship moving with speed through the water, or the tide may cause a discrepancy, or the chart itself may lack perfection; but the soundings should agree in a general way, and a marked departure from the characteristic bottom shown on the chart should lead the navigator to verify his position and proceed with caution; especially is this true if the water is more shoal than expected.

160. But if the soundings in shallow water when landmarks are in sight serve merely as an auxiliary guide, those taken (usually with the patent sounding machine or deep-sea lead) when there exist no other means of locating the position, fulfill a much more important purpose. In thick weather, when approaching or running close to the land, and at all times when the vessel is in less than 100 fathoms of water and her position is in doubt, soundings should be taken continuously and at regular intervals, and, with the character of the bottom, systematically recorded. By laying the soundings on tracing paper, along a line which represents the track of the ship according to the scale of the chart, and then moving the paper over the chart, keeping the various courses parallel to the corresponding directions on the chart, until the observed soundings agree with those laid down, the ship's position will in general be quite well determined. While some localities, by the sharpness of the characteristics of their soundings, lend themselves better than others to accurate determinations by this method, there are few places where the mariner can not at least keep out of danger by the indications, even if they tell him no more than that the time has come when he must anchor or lie off till conditions are more favorable.

161. Lights.—Before coming within range of a light the navigator should acquaint himself with its characteristics, so that when sighted it will be recognized. The charts, sailing directions, and light lists give information as to the color, character, and range of visibility of the various lights. Care should be taken to note all of these and compare them when the light is seen. If the light is of the flashing, revolving, or intermittent variety the duration of its periods should be noted to identify it. If a fixed light, a method that may be employed to make sure that it is not a vessel's light is to descend several feet immediately after sighting it and observe if it disappears from view; a navigational light will usually do so, excepting in misty weather, while a vessel's light will not. The reason for this is that navigational lights are as a rule sufficiently powerful to be seen at the farthest point to which the ray can reach without being interrupted by the earth's curvature. They are therefore seen at the first moment that the ray reaches an observer on a ship's deck, and are cut off if he lowers the eye. A vessel's light, on the other hand, is usually limited by its intensity and does not carry beyond a distance within which it is visible at all heights.

Care must be taken to avoid being deceived on first sighting a light, as there are various errors into which the inexperienced may fall. The glare of a powerful light is often seen beyond the distance of visibility of its direct rays by the reflection downward from particles of mist in the air; the same mist may also cause a white light to have a distinctly reddish tinge, or it may obscure a light except within short distances. When a light is picked up at the extreme limit at which the height of the observer will permit, a fixed light may appear flashing, as it is seen when the ship is on the crest of a wave, and lost when in the hollow.

Many lights are made to show different colors in different sectors within their range, and by consulting his chart or books, the navigator may be guided by the color of the sector in which he finds himself; in such lights one color is generally used on bearings whence the approach is clear, and another covers areas where dangers are to be encountered.

The visibility of lights is usually stated for an assumed height of the observer's eye of 15 feet, and must be modified accordingly for any other height. But it should be remembered that atmospheric and other conditions considerably affect the visibility, and it must not be positively assumed, on sighting a light, even in perfectly clear weather, that a vessel's distance is equal to the range of visibility; it may be either greater or less, as the path of a ray of light near the horizon receives extraordinary deflection under certain circumstances; the conditions governing this deflection are discussed in article 296, Chapter X.

162. Buoys.—While buoys are valuable aids, the mariner should always employ a certain amount of caution in being guided by them. In the nature of things it is never possible to be certain of finding buoys in correct position, or, indeed, of finding them at all. Heavy seas, strong currents, ice, or collisions with passing vessels may drag them from their places or cause them to disappear entirely, and they are especially uncertain in unfrequented waters, or those of nations that do not keep a good lookout upon their aids to navigation. When, therefore, a buoy marks a place where a ship must be navigated with caution, it is well to have a danger angle or bearing as an additional guide instead of placing too much dependence upon the buoy being in place.

Different nations adopt different systems of coloring for their buoys; an important feature of many such systems, including those adopted by the United States and various other great maritime nations (though not all), consists in placing red buoys to be left on the starboard hand of a vessel entering a harbor or fairway, and black buoys on the port hand. In these various systems the color and character of the buoys are such as to denote the special purpose for which they are employed.

163. Fogs and Fog Signals.—As with lights, the navigator should, in a fog, acquaint himself with the characteristics of the various sound signals which he is likely to pick up, and when one is heard, its periods should be timed and compared with those given in the light lists to insure its proper identity.

Experiment has demonstrated that sound is conveyed through the atmosphere in a very uncertain way; that its intensity is not always increased as its origin is approached, and that areas within its range at one time, will seem silent at another. Add to these facts the possibility that, for some cause, the signal may not be working as it should be, and we have reason for observing the rule to proceed with the utmost caution when running near the land in a fog.

Although the transmission of sound through water from the submarine bells that have been installed on many light vessels and at points of danger is much more certain than the transmission of sound through air and can be received in such a way by vessels equipped with submerged microphones on each side as to enable the direction of the submarine bell to be approximately determined, yet the lead continues to prove an ever-serviceable guide, and should accordingly be in constant use.

The method of plotting soundings described in article 160 will give the most reliable position that is obtainable. Moreover, the lead will warn the navigator of the approach to shallow water, when, if his position is at all in doubt, it is wisest to to anchor before it becomes too late.

When running slowly in a fog (which caution, as well as the law, requires that one should do) it must be borne in mind that the relative effect of current is increased; for instance, the angle of deflection from the course caused by a cross-set is greater at low than at high speed.

It is worth remembering that when in the vicinity of a bold bluff shore vessels are sometimes warned of a too close approach by having their own fog signals echoed back from the cliffs; indeed, from a knowledge of the velocity of sound (art. 314, Chap. XI) it is possible to gain some rough idea of the distance in such a case.

When radio-stations, equipped with fog-signaling apparatus, send out simultaneous radio and sound signals, distances from the sending station can be found by noting the elapsed interval between the time of arrival of radio signal and sound signal, and multiplying this interval expressed in seconds by the velocity per second of sound in air, or the velocity per second of sound in water, according as the sound signals are received through air or through water.

By thus determining the distance from a fog-signal station to different positions between which the course and distance are known, the position of the vessel could be approximately found in a manner analogous to that which would apply in figure 18 if the distances AO and AP were known in addition to the length and direction of OP.

164. Tides and Currents.—The information relating to the tides given on the chart and in other publications should be studied, as it is of importance for the navigator to know not only the height of the tide above the plane of reference of the chart, but also the direction and force of the tidal current.

The plane of reference adopted for soundings varies with different charts; on a large number it is that of mean low water, and as no plane of reference above that of mean low water is ever employed the navigator may with safety refer his soundings to that level when in doubt.

When traversing waters in which the depth exceeds the vessel's draft by but a small margin, account must be taken of the fact that strong winds or a high barometer may cause the water to fall below even a very low plane of reference. On coasts where there is much diurnal inequality in the tides, the amount of rise and fall can not be depended upon, and additional caution is necessary.

A careful distinction should be made between the vertical *rise and fall* of the tide, which is marked at the transition periods by a stationary height, or *stand*, and the tidal current, which is the horizontal transfer of water as a result of the difference of level, producing the *flood and ebb*, and the intermediate condition, or *slack*. It seldom occurs that the turn of the tidal stream is exactly coincident with the high and low water, and in some channels the current may outlast the vertical movement which produces it by as much as three hours, the effect being that when the water is at a stand the tidal stream is at its maximum, and when the current is slack the rise or fall is going on with its greatest rapidity. Care must be taken to avoid confounding the two.

The effect of the tidal wave in causing currents may be illustrated by two simple cases:

(1) Where there is a small tidal basin connected with the sea by a large opening.

(2) Where there is a large tidal basin connected with the sea by a small opening.

In the first case the velocity of the current in the opening will have its maximum value when the height of the tide within is changing most rapidly, i. e., at a time about midway between high and low water. The water in the basin keeps at approximately the same level as the water outside. The flood stream corresponds with the rising and the ebb with the falling of the tide.

In the second case the velocity of the current in the opening will have its maximum value when it is high water or low water without, for then there is the greatest head of water for producing motion. The flood stream begins about three hours after low water, and the ebb stream about three hours after high water, slack water thus occurring about midway between the tides.

Along most shores which lack features like bays and tidal rivers, the current usually turns soon after high water and low water.

The swiftest current in straight portions of tidal rivers is usually in the middle of the stream, but in curved portions the most rapid current is toward the outer edge of the curve, and here the water will be deepest. The pilot rule for best water is to follow the ebb-tide reaches.

Countercurrents and eddies may occur near the the shores of straits, especially in bights and near points. A knowledge of them is useful in order that they may be taken advantage of or avoided.

A swift current often occurs in the narrow passage connecting two large bodies of water, owing to their considerable difference of level at the same instant. The several passages between Vineyard Sound and Buzzards Bay are cases in point. In the Woods Hole Passage the maximum strength of the tidal streams occurs near high and low water.

Tide rips are made by a rapid current setting over an irregular bottom, as at the edges of banks where the change of depth is considerable.

Generally speaking, the rise and fall and strength of current are at their minimum along straight stretches of coast upon the open ocean, while bays, bights, inlets, and large rivers operate to augment the tidal effects, and it is in the vicinity of these that one finds the highest tides and strongest currents. The navigator need therefore not be surprised in cruising along a coast to notice that his vessel is set more strongly toward or from the shore in passing an indentation, and that the evidences of tide will appear more marked as he nears its mouth. Usually more complete data are furnished in charts and tide tables regarding the rise and fall, and it frequently occurs that the information regarding the tidal current is comparatively meager; the mariner must therefore take every means to ascertain for himself the direction and force of the tidal and other currents, either from the set shown between successive well-located positions of the ship, or by noting the ripple of the water around buoys, islets, or shoals, the direction in which vessels at anchor are riding, and the various other visible effects of the current.

Current arrows on the chart must not be regarded as indicating absolutely the conditions that are to be encountered. They represent the mean of the direction and force observed, but the observations upon which they are based may not be complete, or there may be reasons that bring about a departure from the normal state.

165. CHARTS.—The chart should be carefully studied, and among other things all of its notes should be read, as valuable information may be given in the margin which it is not practicable to place upon the chart abreast the locality affected.

The mariner will do well to consider the source of his chart and the authority upon which it is based. He will naturally feel the greatest confidence in a chart issued by the Government of one of the more important maritime nations which maintains a well-equipped office for the especial purpose of acquiring and treating hydrographic information. He should note the character of the survey from which the chart has been constructed; and, finally, he should be especially careful that the chart is of recent issue or bears correction of a recent date—facts that should always be clearly shown upon its face.

It is well to proceed with caution when the chart of the locality is based upon an old survey, or one whose source does not carry with it the presumption of accuracy. Even if the original survey was a good one, a sandy bottom, in a region where the currents are strong or the seas heavy, is liable to undergo in time marked changes; and where the depth is affected by the deposit or removal of silt, as in the vicinity of the estuaries of large river systems, the behavior is sometimes most capricious. Large blank spaces on the chart, where no soundings are shown, may be taken as an indication that no soundings were made, and are to be regarded with suspicion, especially if the region abounds in reefs or pinnacle rocks, in which case only the closest sort of a survey can be considered as revealing all the dangers. All of these facts must be duly weighed.

When navigating by landmarks the chart of the locality which is on the largest scale should be used. The hydrography and topography in such charts appear in greater detail, and—a most important consideration—bearings and angles may be plotted with increased accuracy.

To sum up, the navigator must know the exact draft of the ship when approaching the land. He must make himself familiar with every detail of the charts he will be required to use and must read the charts in such a way as to be able to form a mental picture of how the land and the various aids to navigation will look when sighted, remembering that the position of the sun at different times of day, or the position of the moon at night, affects the appearance of the land as presented to the navigator approaching from seaward. He must be thoroughly familiar with the day, night, and fog characteristics of all aids to navigation in the locality. He must know the state of the tide and the force and direction of the current at all times when in pilot waters. The navigator, in making his plan for entering a strange port, should give very careful previous study to the chart, and should carefully select what appear to be the most suitable marks for use, also providing himself with substitutes for use in case those selected as most suitable should prove unreliable by not being recognized with absolute certainty. It must be remembered that buoys seen at a distance, in approaching a channel, are often difficult to place or identify, because all may appear equally distant, though in reality far apart. Ranges should be noted, if possible, and the lines drawn, both for leading through the best water in channels and also for guarding against particular dangers. For the latter purpose, safety bearings should in all cases be laid down where no suitable ranges offer. The courses to be steered in entering should also be laid down and distances marked thereon. If intending to use the sextant and danger angle in passing dangers, and especially in passing between dangers, the danger circles should be plotted and regular courses planned, rather than to run haphazard by the indications of the angle alone, with the possible trouble to be apprehended from wild steering at critical points.

The ship's position should not be allowed to be in doubt at any time, even in entering ports considered safe and easy of access, and should be constantly checked by continuing to use for this purpose those marks concerning which there can be no doubt until others are unmistakably recognized.

The ship should ordinarily steer exact courses and follow exact lines as planned from the chart, changing course at exact points, and, where the distances are considerable, her position on the line should be checked at frequent intervals, recording the time and the reading of the patent log. This is desirable, even where it may seem unnecessary for safety; because, if running by the eye alone and the ship's exact position be suddenly required, as in a sudden squall, fixing at that particular moment might be impossible.

The habit of running exact courses with precise changes of courses will be found most useful when it is desired to enter port or pass through inclosed waters during fog by means of the buoys; here safety demands that the buoys be made successively, to do which requires, if the fog be dense, very accurate courses and careful attention to the times, rate of speed, and the set of the current. Failure to make a buoy as expected leaves no safe alternative but to anchor at once.

It is a useful point to remember that in passing between dangers where there are no suitable leading marks, as, for instance, between two islands or an island and the main shore, with dangers extending from both, a mid-channel course may be steered by the eye alone with great accuracy, as the eye is able to estimate very closely the position midway between visible objects.

In piloting among coral reefs or banks, a time should be chosen when the sun will be astern, conning the vessel from aloft or from an elevated position forward. The line of demarcation between the deep water and the edges of the shoals, which generally show as green patches, is indicated with surprising clearness. This method is of frequent application in the numerous passages of the Florida keys.

Changes of course should in general be made by exact amounts, naming the new course or the amount of the change desired, rather than by ordering the helm to be put over and then steadying when on the desired heading, with the possibility of the attention being diverted and so forgetting in the meantime that the ship is still swinging. The helmsman, knowing just what is desired and the amount of change to be made, is thus enabled to act more intelligently and to avoid wild steering, which in narrow channels is a very positive source of danger.

Coast piloting involves the same principles and requires that the ship's positions be continuously determined or checked as the landmarks are passed. On well-surveyed coasts there is a great advantage in keeping near the land, thus holding on to the marks and the soundings, and thereby knowing at all times the position, rather than keeping offshore and losing the marks, with the necessity of again making the land from vague positions, and perhaps the added inconvenience of fog or bad weather, involving a serious loss of time and fuel.

The route should be planned for normal conditions of weather with suitable variations where necessary in case of fog or bad weather or making points at night, the courses and distances, in case of regular runs over the same route, being entered in a notebook for ready reference, as well as laid down on the chart. The danger circles for either the horizontal or the vertical danger angles should be plotted, wherever the method can be usefully employed, and the angles marked thereon; many a mile may thus be saved in rounding dangerous points, with no sacrifice in safety. Ranges should also be marked in, where useful for positions or for safety, and also to use in checking the deviation of the compass by comparing, in crossing, the compass bearing of the range with its magnetic bearing, as given by the chart.

Changes of course will in general be made with mark or object abeam, the position (a new "departure") being then, as a rule, best and most easily obtained.

In making the land in a fog the sounding machine must be kept going at intervals of half an hour some hours before it is expected that soundings can be obtained. Several soundings taken at random will not locate a ship, but on the contrary may lead to disaster. In using the sounding machine be careful that the man handling the tube does not invert the tube when taking it from the tube case, as this would allow water to run toward the closed end of the tube, causing a discoloration of the coating and thus bring about an incorrect sounding. It is also essential that the lead be cleanly and freshly armed for each cast. The bottom having been picked up, a graphic record of the soundings may be laid down in the manner previously described in paragraph 160 and an approximation made of the position of the ship. Keep a sharp lookout for any landmarks that might show up during a momentary lifting of the fog and have keen ears listening for an aerial or submarine fog signal. Having picked up any such signal, make sure to ascertain exactly what landmark it is. From now on proceed with caution and determine whether it is better to anchor or to proceed through the harbor channel in the fog. If, having approached the land and failed to hear fog signals at the time they were expected to be heard and the soundings indicate a dangerous proximity to shore, the only safe course is either to anchor or to stand off. When running slowly in a fog (which caution, as well as the law, requires that one should do) it must be borne in mind that the relative effect of current is increased; for instance, the angle of deflection from the course caused by a cross set is greater at low than at high speed. It is worth remembering that when in the vicinity of a bold bluff shore vessels are sometimes warned of a too-close approach by having their own fog signals echoed back from the cliffs; indeed, from a knowledge of the velocity of sound it is possible to gain some rough idea of the distance in such a case. Great caution must be used in approaching a bold coast in a fog and, unless soundings can be got that will reasonably assure the navigator of his distance from the coast, the only safe course is to stand off, if the depth of the water does not permit of anchoring.

The best aids at the disposal of the navigator when running in a fog are the sounding machine and the hand lead, and the navigator will do well to make great use of them. Even in clear weather the sounding machine may be a great aid to the navigator in verifying his position.

In approaching the land and entering harbors, the navigator must bear in mind that rules of the road in inland waters sometimes differ from those used on the high sea, and should inform himself of the boundaries of the waters where different rules of the road obtain.

166. Records.—It will be found a profitable practice to pay careful attention to the recording of the various matter relating to the piloting of the ship. A notebook should be kept at hand on deck or on the bridge, in which are to be entered all bearings or angles taken to fix the position, all changes of course, important soundings, and any other facts bearing upon the navigation. (This book should be different from the one in which astronomical sights and offshore navigation are worked.) The entries, though in memorandum form, should be complete; it should be clear whether bearings and courses are true, magnetic, or by compass; and it is especially important that the time and patent log reading should be given for each item recorded. The value of this book will make itself apparent in various directions; it will afford accurate data for the writing of the ship's log; it will furnish interesting information for the next run over the same ground; it will provide a means by which, if the ship be shut in by fog, rain, or darkness, or if there be difficulty in recognizing landmarks ahead, the last accurate fix can be plotted and brought forward; and, finally, if there should be a mishap, the notebook would furnish evidence as to where the trouble has been.

The chart on which the work is done should also be made an intelligible record, and to this end the pencil marks and lines should not be needlessly numerous, heavy, or, long. In plotting bearings, draw lines only long enough to cover the probable position. Mark intersections or positions by drawing a small circle around them, and writing neatly abreast them the time and patent log reading. Indicate the courses and danger bearings by full lines and mark them appropriately, preferably giving both magnetic (or true) and compass directions. A great number of lines extending in every direction may lead to confusion; however remote the chance may seem, the responsibilities of piloting are too serious to run even a small risk.

Finally, on anchoring, record and plot the position by bearings or angles taken after coming to; observe that the berth is a safe one, or, if in doubt, send a boat to sound in the vicinity of the ship to make sure.

CHAPTER V.

THE SAILINGS.

167. In considering a ship's position at sea with reference to any other place, either one that has been left or one toward which the vessel is bound, five terms are involved—the *Course*, the *Distance*, the *Difference of Latitude*, the *Difference of Longitude*, and the *Departure*.[a] The solutions of the various problems that arise from the mutual relation of these quantities are called *Sailings*.

168. KINDS OF SAILINGS.—When the only quantities involved are the course, distance, difference of latitude, and departure, the process is denominated *Plane Sailing*. In this method the earth is regarded as a plane, and the operation proceeds as if the vessel sailed always on a perfectly level surface. When two or more courses are thus considered, they are combined by the method of *Traverse Sailing*. It is evident that the number of *miles* of latitude and departure can thus be readily deduced; but, while one mile always equals one minute in difference of latitude, one mile of departure corresponds to a difference of longitude that will vary with the latitude in which the vessel is sailing. Plane sailing therefore furnishes no solution where difference of longitude is considered, and for such solution resort must be had to one of several methods, which, by reason of their taking account of the spherical figure of the earth, are called *Spherical Sailings*.

When a vessel sails on an east or west course along a parallel of latitude, the method of converting departure into difference of longitude is called *Parallel Sailing*. When the course is not east or west, and thus carries the vessel through various latitudes, the conversion may be made either by *Middle Latitude Sailing*, in which it is assumed that the whole run has been made in the mean latitude, or by *Mercator Sailing*, in which the principle involved in the construction of the Mercator chart (art. 39, Chap. II) is utilized.

Great Circle Sailing deals with the courses and distances between any two points when the track followed is a great circle of the terrestrial sphere. A modification of this method which is adopted under certain circumstances is called *Composite Sailing*.

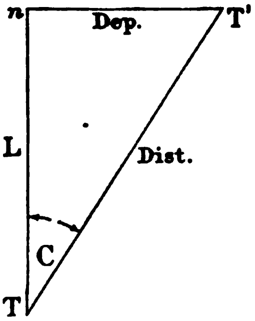

FIG. 24.

PLANE SAILING.

169. In Plane Sailing, the curvature of the earth being neglected, the relation between the elements of the rhumb track joining any two points may be considered from the plane right triangle formed by the meridian of the place left, the parallel of the place arrived at, and the rhumb line. In figure 24, T is the point of departure; T′, the point of destination; Tn, the meridian of departure; T′n, the parallel of destination; and TT′, the rhumb line between the points. Let C represent the course, T′Tn; Dist., the distance, TT′; DL, the difference of latitude, Tn; and Dep., the departure, T′n. Then from the triangle TT′n, we have the following:

$$\sin C = \frac{\text{Dep.}}{\text{Dist.}};$$

$$\cos C = \frac{\text{D L}}{\text{Dist.}};$$

$$\tan C = \frac{\text{Dep.}}{\text{D L}}.$$

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[a] For the definition of these terms, see article 6, Chapter I.

From these equations are derived the following formulæ for working the various problems that may arise in Plane Sailing:

Given.	Required.	Formulæ.	
Course and distance	Difference of latitude	$D\ L = \text{Dist.} \cos C.$	$\text{Log } D\ L = \log \text{Dist.} + \log \cos C.$
	Departure	$\text{Dep.} = \text{Dist.} \sin C.$	$\text{Log Dep.} = \log \text{Dist.} + \log \sin C.$
Difference of latitude and departure.	Course	$\tan C = \frac{\text{Dep.}}{D\ L}.$	$\text{Log} \tan C = \log \text{Dep.} - \log D\ L.$
	Distance	$\text{Dist.} = \frac{\text{Dep.}}{\sin C}.$	$\text{Log Dist.} = \log \text{Dep.} - \log \sin C.$
Course and difference of latitude.	Distance	$\text{Dist.} = \frac{D\ L}{\cos C}.$	$\text{Log Dist.} = \log D\ L - \log \cos C.$
	Departure	$\text{Dep.} = D\ L \tan C.$	$\text{Log Dep.} = \log D\ L + \log \tan C.$
Course and departure	Distance	$\text{Dist.} = \frac{\text{Dep.}}{\sin C}.$	$\text{Log Dist.} = \log \text{Dep.} - \log \sin C.$
	Difference of latitude.	$D\ L = \frac{\text{Dep.}}{\tan C}.$	$\text{Log } D\ L = \log \text{Dep.} - \log \tan C.$
Distance and difference of latitude.	Course	$\cos C = \frac{D\ L}{\text{Dist.}}.$	$\text{Log} \cos C = \log D\ L - \log \text{Dist.}$
	Departure	$\text{Dep.} = \text{Dist.} \sin C.$	$\text{Log Dep.} = \log \text{Dist.} + \log \sin C.$
Distance and departure.	Course	$\sin C = \frac{\text{Dep.}}{\text{Dist.}}.$	$\text{Log} \sin C = \log \text{Dep.} - \log \text{Dist.}$
	Difference of latitude.	$D\ L = \text{Dist.} \cos C.$	$\text{Log } D\ L = \log \text{Dist.} + \log \cos C.$

170. The solution of the plane right triangle may be accomplished either by Plane Trigonometry, by Traverse Tables, or by construction. If the former method is adopted, the logarithms of numbers may be found in Table 42, and of the functions of angles in Table 44. A more expeditious method is available, however, in the Traverse Tables, which give by inspection the various solutions. Table 1 contains values of the various parts for each unit of Dist. from 1 to 300, and for each quarter-point (2° 49′), of C; Table 2 contains values for each unit of Dist. from 1 to 600, and for each degree of C. The method of solving by construction consists in laying down the various given terms by scale upon a chart or plain paper, and measuring thereon the terms required.

171. Of the various problems that may arise, the first two given in the foregoing table are of much the most frequent occurrence. In the first, the given quantities are course and distance, and those to be found are difference of latitude and departure; this is the case where a navigator, knowing the distance run on a given course, desires to ascertain the amount made good to north or south and to east or west. In the second case the conditions are reversed; this arises where the course and distance between two points are to be obtained from their known difference of latitude and departure.

Example: A ship sails SW. by W., 244 miles. Required the difference of latitude and the departure made good.

By Computation.

Dist.	244	log	2.38739
C	56° 15′	log cos	9.74474
DL	135.6	log	2.13213
Dist.	244	log	2.38739
C	56° 15′	log sin	9.91985
Dep.	202.9	log	2.30724

By Inspection.

In Table 1, find the course SW. by W. (5 points); it occurs at the bottom of the page, therefore take the names of the columns from the bottom as well; opposite 244 in the Dist. column will be seen Lat. 135.6 and Dep. 202.9.

Example: A ship sails N. 5° E., 188 miles. Required the difference of latitude and the departure.

By Computation.

Dist.	188	log	2.27416
C	5°	log cos	9.99834
DL	187.3	log	2.27250
Dist.	188	log	2.27416
C	5°	log sin	8.94030
Dep.	16.4	log	1.21446

By Inspection.

In Table 2, find the course 5°; it occurs at the top of the page, therefore take the names of the columns from the top; opposite 188 in the Dist. column will be seen Lat. 187.3 and Dep. 16.4.

Example: A vessel is bound to a port which is 136 miles to the north and 203 miles to the west of her position. Required the course and distance.

By Computation.

Dep.	203	log	2.30750
DL	136	log	2.13354
C	(N.) 56° 11′ (W.)	log tan	0.17396
Dep.	203	log	2.30750
C	56° 11′	log sin	9.91951
Dist.	244.3	log	2.38799

By Inspection.

Enter Table 1 and turn the pages until a course is found whereon the numbers 136 and 203 are found abreast each other in the columns marked respectively Lat. and Dep. This occurs most nearly at the course for 5 points, the angle being taken from the bottom, because the appropriate names of the columns are found there. The course is therefore NW. by W. Interpolating for intermediate values, the corresponding number in the Dist. column is about 244.3.

Example: As a result of a day's run a vessel changes latitude 244 miles to the south and makes a departure of 171 miles to the east. What is the course and distance made good?

By Computation.

Dep.	171	log	2.23300
DL	244	log	2.38739
C	(S.) 35° 02′ (E.)	log tan	9.84561
Dep.	171	log	2.23300
C	35° 02′	log sin	9.75895
Dist.	297.9	log	2.47405

By Inspection.

Enter Table 2 and the nearest agreement will be found on course (S.) 35° (E.), the appropriate names being found at the top of the page. The nearest corresponding Dist. is 298 miles.

TRAVERSE SAILING.

172. A *Traverse* is an irregular track made by a ship in sailing on several different courses, and the method of *Traverse Sailing* consists in finding the difference of latitude and departure corresponding to several courses and distances and reducing all to a single equivalent course and distance. This is done by determining the distance to north or south and to east or west made good on each course, taking the algebraic sum of these various differences of latitude and departure and finding the course and distance corresponding thereto. The work can be most expeditiously performed by adopting a tabular form for the computation and using the traverse tables.

Example: A ship sails SSE., 15 miles; SE., 34 miles; W. by S., 16 miles; WNW., 39 miles; S. by E., 40 miles. Required the course and distance made good.

Courses.	Dist.	N.	S.	E.	W.
SSE.	15		13.9	5.7	
SE.	34		24.0	24.0	
W. by S.	16		3.1		15.7
WNW.	39	14.9			36.0
S. by E.	40		39.2	7.8	
		14.9	80.2	37.5	51.7
			14.9		37.5
S. by W.	66.8		65.3		14.2

The result of the various courses is, therefore, to carry the vessel S. by W., 66.8 miles from her original position.

PARALLEL SAILING.

173. Thus far the earth has been regarded as an extended plane, and its spherical figure has not been taken into account; it has thus been impossible to consider one of the important terms involved—namely, difference of longitude. *Parallel Sailing* is the simplest of the various forms of Spherical Sailing, being the method of interconverting departure and difference of longitude when the ship sails upon an east or west course, and therefore remains always on the same parallel of latitude.

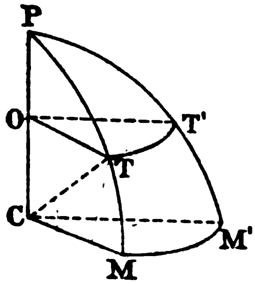

FIG. 25.

In figure 25, T and T′ are two places in the same latitude; P, the adjacent pole; TT′, the arc of the parallel of latitude through the two places; MM′, the corresponding arc of the equator intercepted between their meridians PM and PM′; and TT′, the departure on the parallel whose latitude is TCM = OTC, and whose radius is OT.

Let D.Lo represent the arc of the equator MM′, which is the measure of MPM′, the difference of longitude of the meridians PM and PM′; R, the equatorial radius of the earth, CM = CT; r, the radius OT of the parallel TT′; and L, the latitude of that parallel.

Then, since TT′ and MM′ are similar arcs of two circles, and are therefore proportional to the radii of the circles, we have:

$$\frac{TT'}{MM'}=\frac{OT}{CM};\ \text{or,}\ \frac{\text{Dep.}}{\text{D.Lo}}=\frac{r}{R}.$$

From the triangle COT, $r = R \cos L$; hence

$$\frac{\text{Dep.}}{\text{D.Lo}}=\frac{R\cos L}{R};\ \text{or, D.Lo} = \text{Dep. sec. L; or,}\ \boxed{\text{Dep.} = \text{D.Lo}\cos L.}$$

Thus the relations are expressed between *minutes* of longitude and *miles* of departure.

174. Two cases arise under Parallel Sailing: First, where the difference of longitude between two places on the same parallel is given, to find the departure; and, second, where the departure is given, to find the difference of longitude.

In working these problems, the computation can be made by logarithms; but the traverse tables may more conveniently be employed. Remembering that those tables are based upon the formulæ,

$$\text{DL} = \text{Dist. cos C, and Dist.} = \text{DL sec C},$$

we may substitute for the column marked Lat. the departure, for that marked Dist. the difference of longitude, and for the courses at top and bottom of the page the latitude. The tables then become available for making the required conversions.

EXAMPLE: A ship in the latitude of 49° 30′ sails directly east until making good a difference of longitude of 3° 30′. Required the departure.

By Computation.

L	49° 30′	log cos	9.81254
D.Lo.	210′	log	2.32222
Dep.	136.4	log	2.13476

By Inspection.

Enter Table 2 with the latitude as C and the difference of longitude as Dist. As the table is calculated only to single degrees, we must find the numbers in the pages of 49° and 50° and take the mean. Corresponding to Dist. 210 in the former is Lat. 137.8, and in the latter Lat. 135.0. The mean, which is the required departure, is 136.4.

EXAMPLE: A ship in the latitude of 38° sails due west a distance of 215.5 miles. Required the difference of longitude.

By Computation.

L	38°	log sec	0.10347
Dep.	215.5	log	2.33345
D.Lo	273′.5 4° 33′.5	log	2.43692

By Inspection.

Entering Table 2 with the latitude, 38°, as a course, corresponding with the number 215.5 in column of Lat., is 273.5 in the column of Dist. This is therefore the required difference of longitude, being equal to 4° 33′.5.

MIDDLE LATITUDE SAILING.

175. When a ship follows a course obliquely across the meridian the latitude is constantly changing, and the method of converting departure and difference of longitude by Parallel Sailing, just described, ceases to be applicable.

In figure 26, T is the point of departure; T′, the point of destination; P, the earth's pole; TT′, the rhumb track; n_1TT′, the course; Tn, n_1T′, the respective parallels of latitude; and MM′, the equator.

The difference of longitude between T and T′ is MPM′, which may be measured by the arc of the equator, MM′, intercepted between their meridians. This corresponds to a departure Tn in the latitude of T, and to the smaller departure T′n_1 in the higher latitude of T′; but since the vessel neither makes all of the departure in the latitude T, nor all of it in the latitude T′, the departure actually made in the passage must have some intermediate value between these extremes. Dividing the total difference of longitude into a number of equal parts MPm_1, m_1Pm_2, etc., of such small extent that, for the purposes of conversion, the change of latitude corresponding to each may be neglected, we have the total departure made up of the sum of a number of small departures, each equal to the same difference of longitude, but each different from the other. These will be d_1r_1 in the latitude T, d_2r_2 in the latitude r_1, etc. Hence we have:

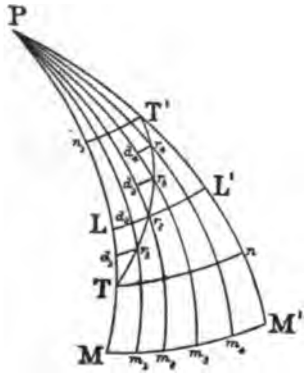

FIG. 26.

$$\mathrm{MM}' = d_1r_1 \sec \mathrm{MT} + d_2r_2, \sec m_1r_1 + d_3r_3, \sec m_2r_2, + \text{etc.}$$

Now, if LL′ be a parallel of latitude lying midway between Tn and T′n_1, since there will be as many of the small parts lying above as below it, and since for moderate distances the ratio to be employed in the conversion of departure and difference of longitude may be regarded as varying directly with the latitude, it may be assumed for such distances that the sum of all of the different small departures equals the single departure between the meridians measured in the latitude LL′, and therefore that the departure obtained by the method of plane sailing on any course may be converted into difference of longitude by multiplying by the secant of the Middle Latitude.

The method of conversion based upon this assumption is denominated *Middle Latitude Sailing*, and by reason of its convenience and simplicity is usually employed for short distances, such as those covered by a vessel in a day's run.

176. In Middle Latitude Sailing, having found the mean of the latitudes, the solution is identical with that of Parallel Sailing (art. 173), substituting the Middle Latitude for the single latitude therein employed.

EXAMPLE: A ship in Lat. 42° 30′ N., Long. 58° 51′ W., sails SE. by S., 300 miles. Required the latitude and longitude arrived at.

From Table 1: Course SE. by S., Dist., 300, we find Lat., 249.4 S. (4° 09′.4), Dep., 166.7 E.

Latitude left,	42° 30′.0 N.	Latitude left,	42° 30′ N.
DL,	4 09 .4 S.	Latitude arrived at,	38 21 N.
Latitude arrived at,	38 20 .6 N.		2)80 51
		Mid. latitude,	40 25 N.

Enter Table 2 with the middle latitude, 40°, as a course; the difference of longitude (Dist.) corresponding to the departure (Lat.) 166.7 is 217.6; entering with 41°, it is 220.9; the mean is 219.2 (3° 39′.2).

Longitude left,	58° 51′.0 W.
D.Lo,	3 39 .2 E.
Longitude arrived at,	55 11 .8 W.

EXAMPLE: A ship in Lat. 39° 42′ S., Long. 3° 31′ E., sails S. 42° W., 236 miles. Required the latitude and longitude arrived at.

From Table 2: Course, S. 42° W., Dist., 236 miles; we find Lat., 175.4 S. (2° 55′.4), Dep., 157.9 W.

Latitude left,	39° 42′.0 S.	Latitude left,	39° 42′ S
DL,	2 55 .4 S.	Latitude arrived at,	42 37 S.
Latitude arrived at,	42 37 .4 S.		2)82 19
		Mid. latitude,	41 09 S.

From Table 2: Mid. Lat. (course), 41°, Dep. (Lat.), 157.9; we find D.Lo (Dist.), 209.3 (3° 29′.3).

Longitude left,	3° 31′.0 E.
D.Lo,	3 29 .3 W.
Longitude arrived at,	0 01 .7 E.

Example: A vessel leaves Lat. 49° 57′ N., Long. 15° 16′ W., and arrives at Lat. 47° 18′ N., Long. 20° 10′ W. Required the course and distance made good.

Latitude left	49° 57′ N.	Longitude left,	15° 16′ W.
Latitude arrived at,	47 18 N.	Longitude arrived at,	20 10 W.
DL,	$\left\{\begin{matrix} 2^\circ\ 39' \\ 159' \end{matrix}\right\}$S.	D.Lo,	$\left\{\begin{matrix} 4^\circ\ 54' \\ 294' \end{matrix}\right\}$W.
	2)97° 15′ N.		
Mid. latitude,	48 38 N.		

From Table 2: Mid. Lat. (course), 49°, D.Lo (Dist.), 294; we find Dep. (Lat.), 192.9.
From Table 2: DL 159 S., Dep. 192.9 W., we find course S. 51° W., Dist., 251 miles.

177. It may be remarked that the Middle Latitude should not be used when the latitudes are of opposite name; if of different names and the distance is small, the departure may be assumed equal to the difference of longitude, since the meridians are sensibly parallel near the equator; but if the distance is great the two portions of the track on opposites of the equator must be treated separately.

178. The assumption upon which Middle Latitude sailing is based—that the conversion may be made as if the whole distance were sailed upon a parallel midway between the latitudes of departure and destination—while sufficiently accurate for moderate distances, may be materially in error where the distances are large. In such case, either the method of Mercator Sailing (art. 179) must be employed, or else the correction given in the following table should be applied to the mean latitude to obtain what may be termed the latitude of conversion, being that latitude in which the required conditions are accurately fulfilled. The table is computed from the formula:

$$\cos L_c = \frac{l}{m},$$

where L_c represents the latitude of conversion, and l and m are respectively the differences of latitude and of meridional parts (art. 40, Chap. II) between the latitudes of departure and destination.[a]

Mid. Lat.	*Difference of latitude.*															Mid. Lat.
	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	12°	14°	16°	18°	20°	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
15	−86	−85	−84	−83	−81	−79	−76	−73	−69	−65	−56	−46	−34	−21	− 6	15
18	−67	−67	−66	−65	−63	−61	−59	−56	−53	−50	−43	−34	−23	−12	1	18
21	−54	−54	−53	−52	−51	−49	−47	−44	−42	−39	−32	−24	−15	− 5	7	21
24	−44	−44	−44	−42	−41	−40	−38	−36	−33	−31	−24	−17	− 8	1	12	24
30	−31	−30	−29	−29	−28	−26	−24	−23	−20	−18	−12	− 6	1	11	21	30
35	−23	−22	−21	−21	−19	−18	−17	−15	−12	−10	− 5	2	10	18	28	35
40	−17	−16	−15	−14	−13	−12	−10	− 8	− 6	− 4	2	8	16	25	34	40
45	−12	−11	−11	−10	− 8	− 7	− 5	− 3	− 1	1	7	14	22	31	41	45
50	− 8	− 8	− 7	− 6	− 5	− 3	− 1	1	3	6	12	20	28	38	49	50
55	− 5	− 5	− 4	− 3	− 2	0	2	5	7	10	17	25	35	46	58	55
58	− 4	− 3	− 3	− 1	0	2	4	7	10	13	20	29	39	51	64	58
60	− 3	− 3	− 2	− 1	1	3	5	8	11	14	22	32	43	55	69	60
62	− 3	− 2	− 1	0	2	4	7	9	13	17	25	35	46	60	75	62
64	− 2	− 1	0	1	3	5	8	11	14	18	27	38	50	65	81	64
66	− 2	− 1	0	2	4	6	9	12	16	20	30	42	55	71	89	66
68	− 1	0	1	2	5	7	10	14	18	22	33	46	61	78	98	68
70	− 1	0	1	3	5	8	12	16	20	25	37	51	67	87	109	70
72	0	0	2	4	6	10	13	18	23	28	41	57	76	97	123	72

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[a] The statement often made that the latitude of conversion is always greater than the middle latitude is not correct when the compression of the earth is taken into account, as an inspection of the table will show; that statement is based upon an assumption that the earth is a perfect sphere, and it was upon that assumption that a table which appeared in early editions of this work was computed. The value of the compression adopted for this table is $\frac{1}{293.465}$.

EXAMPLE: A vessel sails from Lat. 10° 13′ S. to Lat. 20° 21′ S., making a departure of 432 miles. Required the difference of longitude.

Latitude left,	10° 13′	S.	
Latitude arrived at,	20 21	S.	
	2)30 34		For Mid. Lat. 15° and Diff. of Lat. 10°. Correction, −65′.
Mid. latitude,	15 17	S.	
Correction,	− 1 05		
L_c,	14 12	S.	

L_c	14° 12′	log sec	.01348
Dep.	432	log	2.63548
D.Lo	445′.6	log	2.64896

MERCATOR SAILING.

179. *Mercator Sailing* is the method by which values of the various elements are determined from considering them in the relation in which they are plotted upon a chart constructed according to the Mercator projection.

180. Upon the Mercator chart (art. 39, Chap. II), the meridians being parallel, the arc of a parallel of latitude is shown as equal to the corresponding arc of the equator; the length of every such arc is, therefore, expanded; and, in order that the rhumb line may appear as a straight line, the meridians are also expanded by such amount as is necessary to preserve, in any latitude, the proper proportion existing between a unit of latitude and a unit of longitude. The length of small portions of the meridian thus increased are called *meridional parts* (art. 40, Chap. II), and these, computed for every minute of latitude from 0° to 80°, form the Table of Meridional Parts (Table 3), by means of which a Mercator chart may be constructed and all problems of Mercator Sailing may be solved.

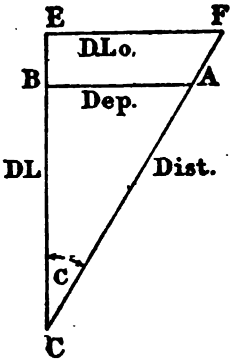

FIG. 27.

In the triangle ABC (fig. 27), the angle ACB is the course, C; the side AC, the distance, Dist.; the side BC, the difference of latitude, DL; and the side AB, the departure, Dep. Then corresponding to the difference of latitude BC in the latitude under consideration, if CE be laid off to represent the meridional difference of latitude, *m*, completing the right triangle CEF, EF will represent the difference of longitude, D.Lo. The triangle ABC gives the relations involved in Plane Sailing as previously described; the triangle CEF affords the means for the conversion of departure and difference of longitude by Mercator Sailing.

181. To find the arc of the expanded meridian intercepted between any two parallels, or the *meridional difference of latitude*, when both places are on the same side of the equator, subtract the meridional parts of the lesser latitude, as given by Table 3, from the meridional parts of the greater; the remainder will be the meridional difference of latitude; but if the places are on different sides of the equator, the sum of the meridional parts will be the meridional difference of latitude.

182. To solve the triangle CEF by the traverse tables it is only necessary to substitute meridional difference for Lat., and difference of longitude for Dep. Where long distances are involved, carrying the computation beyond the limits of the traverse table, as frequently occurs in this method, either of two means may be adopted: the problems may be worked by trigonometrical formulæ, using logarithms or the given quantities involved may all be reduced by a common divisor until they fall within the traverse table, and the results, when obtained, correspondingly increased. The former method is generally preferable, especially when the distances are quite large and accurate results are sought. The formulæ for the various conversions are as follows:

$$\tan C = \frac{\text{D.Lo}}{m}; \quad \text{D.Lo} = m \tan C; \quad m = \text{D.Lo} \cot C.$$

Example: A ship in Lat. 42° 30′ N., Long. 58° 51′ W., sails SE. by S., 300 miles. Required the latitude and longitude arrived at.

From Table 1: Course, SE. by S., Dist., 300; we find Lat. 249.4 S. (4° 09′.4).

Latitude left,	42° 30′.0 N.	Merid. parts, +2806.4
DL,	4 09 .4 S.	
Latitude arrived at,	38 20 .6 N.	Merid. parts, −2480.4
		m, 326.0

By Computation.

m	326.0	log	2.51322
C	33° 45′	log tan	9.82489
D.Lo	217′.8 3° 37′.8	log	2.33811

By Inspection.

Enter Table 1, course 3 points; since the quantities involved exceed the limits of the table, divide by 2; abreast $\frac{m}{2}$ (Lat.), 163.0, find $\frac{\text{D.Lo}}{2}$ (Dep.), 108.9; hence D.Lo=217′.8 or 3° 37′.8.

Longitude left,	58° 51′.0 W.
D.Lo,	3 37 .8 E.
Longitude arrived at,	55 13 .2 W.

Example: A ship in Lat. 4° 37′ S., Long. 21° 05′ W., sails N. 14° W., 450 miles. Required the latitude and longitude arrived at.

From Table 2: Course, (N.) 14° (W.), Dist., 450; we find Lat. 436.6 N. (7° 16′.6).

Latitude left,	4° 37′.0 S.	Merid. parts, +275.4
DL,	7 16 .6 N.	
Latitude arrived at,	2 39 .6 N.	Merid. parts, +159.0
		m, 434.4

By Computation.

m	434.4	log	2.63789
C	14°	log tan	9.39677
D.Lo	108′.3 1° 48′.3	log	2.03466

By Inspection.

From Table 2: Course, 14°, *m* (Lat.), 434.4, we find D.Lo (Dep.) 108′.3 W., or 1° 48′.3.

Longitude left,	21° 05′.0 W.
D.Lo,	1 48 .3 W.
Longitude arrived at,	22 53 .3 W.

Example: Required the course and distance by rhumb line from a point in Lat. 42° 03′ N., Long. 70° 04′ W., to another in Lat. 36° 59′ N., Long. 25° 10′ W.

Lat. departure,	42° 03′ N.	Merid. pts.,	+2770.1	Long. departure,	70° 04′ W.
Lat. destination,	36 59 N.	Merid. pts.,	−2377.3	Long. destination,	25 10 W.
DL	5° 04′ 304′ S.	*m*,	392.8	D.Lo	44° 54′ 2694′ E.

D.Lo	2694	log	3.43040		
m	392.8	log	2.59417		
C (S.) 81° 42′ (E.)		log tan	.83623	log sec.	.84056
DL	304′			log	2.48287
Dist.	2106			log	3.32343

The course is therefore S. 81° 42′ E., and the distance is 2,106 miles. Since the figures involved are so large, it is best to employ only the method by computation. The formula by which the Dist. is obtained comes from Plane Sailing.

GREAT CIRCLE SAILING.

183. The shortest distance between any two points on the earth's surface is measured by the arc of the great circle which passes through those points; and the method of sailing in which the arc of a great circle is employed for the track of the vessel, taking advantage of the fact that it is the shortest route possible, is denominated *Great Circle Sailing*.

184. It frequently happens when a great circle route is laid down that it is found to lead across the land, or to carry the vessel into a region of dangerous navigation or extreme cold which it is expedient to avoid; in such a case a certain parallel should be fixed upon as a limit of latitude, and a route laid down such that a great circle is followed as far as the limiting parallel, then the parallel itself, and finally another great circle to the port of destination. Such a modification of the great circle method is called *Composite Sailing*.

185. The *rhumb line* (art. 6, Chap. I), also called the *loxodromic curve*, which cuts all the meridians at the same angle, has been largely employed as a track by navigators on account of the ease with which it may be laid down on a Mercator chart. But as it is a longer line than the great circle between the same points, intelligent navigators of the present day use the latter wherever practicable. On the Mercator chart, however, the arc of a great circle joining two points (unless both are on the equator or both on the same meridian) will not be projected as a straight line, but as a curve which seems to be longer than the rhumb line; hence the shortest route appears as a circuitous one, and this is doubtless the reason that a wider use of the great circle has not been made.

It should be clearly understood that it is the rhumb line which is in fact the indirect route, and that in following the great circle the vessel is always heading for her port, exactly as if it were in sight, while on the course which is shown as a straight line on the Mercator chart the vessel never heads for her port until at the very end of the voyage.

186. The method of great circle sailing is of especial value to steamers, as such vessels need not, in the choice of a route, have regard for the winds to the same extent as must a sailing vessel; but even in navigating vessels under sail a knowledge of the great circle course may prove of great value. For example, suppose a ship to be bound from Sydney to Valparaiso; the first great circle course is SE. by S., while the Mercator course is almost due east. The distance is 748 miles shorter by the former route (if the great circle is followed throughout, though this would lead to a latitude of 61° S.). With the wind at E. ½ S. the ship would lie nearer to the Mercator course on the starboard tack, assuming that she sailed within six points of the wind; but if she took that tack she would be increasing her distance from the port of destination by 4½ miles in every 10 that she sailed; while on the port tack, heading one point farther from the rhumb, the gain toward the port would be 9½ miles out of every 10. Any course between East and SSW. would be better than the Mercator course; and if the wind were anything to the eastward of SE. by S., the ship would gain by taking the port tack in preference to the starboard.

187. As the great circle makes a different angle with each meridian that is crossed, it becomes necessary to make frequent changes of the ship's course; in practice, the course is a series of chords joining the various points on the track line.

If, while endeavoring to follow a great circle, the ship is driven from it, as by unfavorable weather, it will not serve the purpose to return to the old track at convenience, but it is required that another great circle be laid down, joining the actual position in which the ship finds herself with the port of destination.

188. The methods of determining the great circle course may be divided generally into four classes; namely, by *Great Circle Sailing Charts*, by *Computation*, by the methods of the *Time Azimuth*, and by *Graphic Approximations*.

189. GREAT CIRCLE SAILING CHARTS.—Of the available methods, that by means of charts especially constructed for the purpose is considered greatly superior to all others.

A series of great circle sailing charts covering the navigable waters of the globe is published by the United States Hydrographic Office. Being on the gnomonic projection (art. 44, Chap. II), all great circles are represented as straight lines, and it is only necessary to join any two points by such a line to represent the great circle track between them. The courses and distance are readily obtainable by a method explained on the charts. The track may be transferred to a chart on the Mercator projection by plotting a number of its points by their coordinates and joining them with a curved line.

The navigator who contemplates the use of great circle tracks will find it of the greatest convenience to be provided with these gnomonic charts for the regions which his vessel is to traverse.

190. By Computation.—This method consists in determining a series of points on the great circle by their coordinates of latitude and longitude, plotting them upon a Mercator chart, and tracing the curve that joins them. The first point determined is the *vertex*, or point of highest latitude, even when, as sometimes occurs, it falls without that portion of the great circle which joins the points of departure and destination.

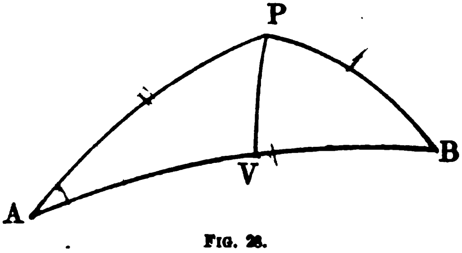

Fig. 28.

In figure 28, A represents the point of departure; B, the point of destination; AVB, the great circle joining them, with its vertex at V; and P, the pole of the earth.

Let C_A = PAB, the initial course;

C_B = PBA, the final course;

L_A, L_V, L_B = the latitudes of the respective points A, V, B = $(90° - PA)$, $(90° - PV)$, $(90° - PB)$.

Lo_{AB}, Lo_{AV}, Lo_{BV} = the differences of longitude between A and B, A and V, B and V, respectively, = APB, APV, BPV.

D = the great circle distance between A and B; and

φ = an auxiliary angle introduced for the computation.

We then have:

$$\tan \varphi = \cos Lo_{AB} \cot L_B;$$
$$\cot C_A = \cot Lo_{AB} \cos (L_A + \varphi) \operatorname{cosec} \varphi;$$
$$\cot D = \cos C_A \tan (L_A + \varphi);$$
$$\cos L_V = \sin C_A \cos L_A;$$
$$\cot Lo_{AV} = \tan C_A \sin L_A.$$

By these formulæ are determined the initial course and the total distance by great circle; also the latitude of the vertex and its longitude with respect to A. By interchanging the subscript letters $_A$ and $_B$ throughout, we should obtain the final course, and the longitude of the vertex with respect to B; also the same total distance and latitude of the vertex as before.

In performing this computation, strict regard must be had to the signs of the quantities. If the points of departure and destination are in different latitudes, the latitude of one of these points must be regarded as negative with respect to the other, and they must be marked with opposite signs. Should Lo_{AV} or Lo_{BV} assume a negative value, it indicates that the vertex does not lie between A and B, and is to be laid off accordingly.

To find other points of the great circle, M, N, etc., let their latitudes be represented by L_M, L_N, etc., and their longitudes from the vertex by Lo_{VM}, Lo_{VN}, etc.; then

$$\tan L_M = \tan L_V \cos Lo_{VM}; \text{ or, } \cos Lo_{VM} = \tan L_M \cot L_V;$$
$$\tan L_N = \tan L_V \cos Lo_{VN}; \text{ or, } \cos Lo_{VN} = \tan L_N \cot L_V;$$

and so on. By these formulæ intervals of longitude from the vertex of 5°, 10°, or any amount, may be assumed, and the corresponding latitudes deduced; or any latitude may be assumed and its corresponding interval of longitude from the vertex found. Two positions will result from each solution, and the appropriate ones may be chosen by keeping in mind the signs involved.

Example: Given two places, one in Lat. 40° N., Long. 70° W., the other in Lat. 30° S., Long. 10° W., find the great circle distance between them; also the initial course, and the longitude of equator crossing.

$$L_A = +40°; \; L_B = -30°; \; Lo_{AB} = 60°.$$

Lo_{AB}	60°	cos	9.69897	cot	9.76144						
L_B	− 30°	cot (−)	.23856								
L_A	+ 40°							cos	9.88425	sin	9.80807
φ	− 40° 54′	tan (−)	9.93753	cosec (−)	.18393						
$(L_A+\varphi)$	− 0° 54′			cos	9.99995	tan (−)	8.19616				
C_A	131° 24′ *or* S. 48° 36′ E.			cot	(−) 9.94532	cos (−)	9.82041	sin	9.87513	tan (−)	.05472
D	89° 24′ *or* 5,364 miles					cot	8.01657				
L_V	+ 54° 56′							cos	9.75938		
Lo_{AV}	− 53° 54′									cot (−)	9.86279

The initial course is therefore S. 48° 36′ E., and the distance 5,364 nautical miles. (It may be found that the course by rhumb line is S. 38° 45′ E. and the distance 5,386 miles.) The vertex of the great circle is in Lat. 54° 56′ N., and is 53° 54′ in longitude from the point A, in a direction away from B; hence it is in Long. 123° 54′ W. To find the longitude of equator crossing let $L_X = 0°$; then in the equation,

$$\cos Lo_{VX} = \tan L_X \cot L_V,$$

since tan L_X equals zero, cos Lo_{VX} also equals zero, or the longitude interval from the vertex is 90°, which is evident from the properties of the great circle: therefore the longitude of equator crossing is 123° 54′ W.—90° = 33° 54′ W.

191. By Time Azimuth Methods.—A convenient method of obtaining the initial and final courses in great circle sailing is afforded by the tables and graphic methods which are prepared for the solution of the *Time Azimuth* problem (art. 352, Chap. XIV). It will be found by comparison that if the latitude of the point of departure be substituted for the latitude of the observer in that problem, the latitude of destination for the declination of the celestial body, and the longitude interval for the hour angle, the solution for the initial course will coincide with that for the azimuth; by interchanging the latitudes of the points of departure and destination the final course will be similarly obtained. Advantage may thus be taken of the various methods provided for facilitating the determination of the azimuth to ascertain the great circle courses from one point to another.

192. By Graphic Approximations.—Of the numerous methods that fall within this class only two need be given.

193. By the use of a *Terrestrial Globe* the two given points between which the great circle track is required may be joined by the shortest line between them, either by means of a piece of thread or by moving the globe until they are brought to the fixed horizon which is usually provided; the coordinates of the various points of the track are then transferred to the chart. The number of minutes of arc, as measured on the scale of the horizon between the points, equals the number of miles of distance; if there be no horizon, the measure may be made by a thread along the equator or a meridian.

194. The *Method of Professor Airy* consists in drawing on the chart a rhumb line joining the two points, and erecting at its middle point a perpendicular; the following table should then be entered with the middle latitude as an argument, and the "corresponding parallel" of latitude taken out (noting whether it is the same or opposite in name to the middle latitude); where this parallel is intersected by the perpendicular that was drawn will be the center from which may be swept an arc approximately representing the great circle between the two points.

Middle latitude.	Corresponding parallel.	Name.	Middle latitude.	Corresponding parallel.	Name.
°	° ′		°	° ′	
20	81 13	Opposite.	52	11 33	Opposite.
22	78 16	Do.	54	6 24	Do.
24	74 59	Do.	56	1 13	Do.
26	71 26	Do.	58	4 00	Same.
28	67 38	Do.	60	9 15	Do.
30	63 37	Do.	62	14 32	Do.
32	59 25	Do.	64	19 50	Do.
34	55 05	Do.	66	25 09	Do.
36	50 36	Do.	68	30 30	Do.
38	46 00	Do.	70	35 52	Do.
40	41 18	Do.	72	41 14	Do.
42	36 31	Do.	74	46 37	Do.
44	31 38	Do.	76	52 01	Do.
46	26 42	Do.	78	57 25	Do.
48	21 42	Do.	80	62 51	Do.
50	16 39	Do.			

COMPOSITE SAILING.

195. It has already been stated that when, for any reason, it is impracticable or unadvisable to follow the great circle track to its highest latitude, a limiting parallel is chosen and the route modified accordingly. This method is denominated *Composite Sailing.*

196. The shortest track between points where a fixed latitude is not exceeded is made up as follows:

1. A great circle through the point of departure tangent to the limiting parallel.
2. A course along the parallel.
3. A great circle through the point of destination tangent to the limiting parallel.

The composite track may be determined by *Great Circle Sailing Chart,* by *Computation,* or by *Graphic Approximation.*

197. On a *Great Circle Sailing Chart,* draw lines from the points of departure and destination, respectively, tangent to the limiting parallel; transfer these great circles to a Mercator chart in the usual manner, by the coordinates of several points, including in each case the point of tangency to the parallel. Follow the first great circle to the parallel; then follow the parallel; then the second great circle. Determine great circle courses and distances from the gnomonic chart as thereon described; determine the distance along the parallel by Parallel Sailing.

198. *By computation,* the problem consists in finding the great circles which pass, respectively, through the points of departure and destination and have their vertices in the latitude of the limiting parallel. Resuming the designation of terms already employed (art. 190), we have:

$$\cos Lo_{VA} = \tan L_A \cot L_V;$$
$$\cos Lo_{VB} = \tan L_B \cot L_V;$$

where Lo_{VA} and Lo_{VB} represent the distances in longitude from A and from B to the respective points of tangency; other features of each of the great circles may be determined in the usual manner.

EXAMPLE: A vessel in Lat. 30° S., Long. 18° W., is bound to a point in Lat. 39° S., Long. 145° E., and it is decided not to go south of the parallel of 55° S. Find the longitude of reaching that parallel and the longitude at which it should be left.

$L_A = 30°$ S.; $L_B = 39°$ S.; $L_V = 55°$ S.
$Lo_A = 18°$ W.; $Lo_B = 145°$ E.

L_A	30°	tan	9.76144	L_B	39°	tan	9.90837
L_V	55°	cot	9.84523	L_V	55°	cot	9.84523
Lo_{VA}	66° 09′ E.	cos	9.60667	Lo_{VB}	55° 27′ W.	cos	9.75360
Lo_A	18 00 W.			Lo_B	145 00 E.		
Lo_V	48 09 E.			Lo_V	89 33 E.		

199. A *graphic approximation* to the composite track may be obtained by drawing a straight line between the given points on a Mercator chart and erecting at its middle point a perpendicular, which should be extended until it intersects the limiting parallel. Then through this intersection and the two points describe the arc of a circle, and this will approximate to the shortest distance within the assigned limit of latitude.

200. A terrestrial globe may be employed for the determination of the composite track; the method of its use will suggest itself.

201. Another approximation is obtained by joining the two points with a single great circle, and following this to its intersection with the limiting parallel; thence sailing along the parallel until the great circle is again intersected; then resuming the circle and following it to the destination.

CHAPTER VI.

DEAD RECKONING.

202. *Dead Reckoning* is the process by which the position of a ship at any instant is found by applying to the last well-determined position the run that has since been made, using for the purpose the ship's course and the distance indicated by the log.

203. Positions by dead reckoning, also spoken of as positions *by account*, differ from those determined by bearings of terrestrial objects or by observations of celestial bodies in being less exact, as the correctness of dead reckoning depends upon the accuracy of the estimate of the run, and this is always liable to be at fault to a greater or less extent. The course made good by a ship may differ from that which it is believed that she is making good, by reason of imperfect steering, improper allowance for compass error and leeway, and the effects of unknown currents; the allowed distance over the ground may be in error on account of inaccurate logging and unknown currents.

Notwithstanding its recognized defects as compared with the more exact methods, the dead reckoning is an invaluable aid to the mariner. It affords him a means of plotting the position of the ship at any desired time between astronomical determinations; it also gives him an approximate position at the moment of taking astronomical observations which is a great convenience in working up those observations; and finally it affords the only available means of determining the location of a vessel at sea during those periods (which may continue for several days together) when the weather is such as to render the observation of celestial bodies an impossibility.

204. TAKING DEPARTURE.—Before losing sight of the land, and preferably while objects remain in good view, it is the duty of the navigator to *take a departure;* this consists in fixing the position of the ship by the best means available (Chap. IV), and using this position as the origin for dead reckoning. There are two methods of reckoning the departure. The first and simpler consists in taking from the chart the latitude and longitude of the position found, and applying the future run thereto. The other requires that the bearing and distance of an object of known latitude and longitude be found; the position of the object then forms the basis of the reckoning, and the *reversed* direction of the bearing, with the distance, forms the first course and distance; thus it may be considered that the ship starts from the position of the object and sails to the position where the bearing was taken; the correction for deviation in such a case should be that due to the heading of the ship when the bearing was taken. Each time that a new position is determined it is used as a new departure for the dead reckoning.

This meaning of the term *departure* should not be confounded with the other, which refers to the distance run toward east or west.

205. METHODS.—The working of dead reckoning merely involves an application of the methods of Traverse Sailing (art. 172) and Middle Latitude Sailing (art. 175), as explained in Chapter V.

The various compass courses are set down in a column, and abreast each are written the errors by reason of which the course steered by compass differs from the true course made good over the ground; thence the true course made good is determined and recorded; next, the distance is written in, and afterwards, by means of Tables 1 or 2 (according as the courses are expressed in quarter points or degrees), the difference of latitude and departure are found, separate columns being kept for distances to the north, south, east, and west.

When the position of the ship at any moment is required, add up all the differences of latitude and departure, and write in the column of the greater the difference between the northing and southing, and the easting and westing. Apply the difference of latitude to the latitude of the last determined position, which will give the latitude by D. R., and from which may be found the middle latitude; with the middle latitude find the difference of longitude corresponding to the departure, apply this to the longitude of last position, and the result will be the longitude by D. R.

The employment of the tabular form will be found to facilitate the work and guard against errors. It will be a convenience to include in that form columns showing the hour, together with the reading of the patent log (if used) each time that the course is changed or the dead reckoning worked up.

The employment of minutes and tenths in dead reckoning rather than minutes and seconds is recommended.

Example: A vessel under sail heading NE. ¾ E. (on which course deviation is ¼ pt. Easterly) takes departure from Cape Henry lighthouse (see Appendix IV for position), bearing SSW. ½ W. per compass, distant 1.4 miles. She then sails on a series of courses, with errors and distances as indicated below; wind about SE. by E. Required the position by dead reckoning; also the course and distance made good by dead reckoning.

Comp. course.	Var.	Dev.	Leeway.	Error.	True course.	Dist.	N.	S.	E.	W.	D. Lo.
NNE. ½ E.	½ W.	¼ E.		¼ W.	NNE. ¼ E.	1.4	1.3		0.6		
NE. ¾ E.	½ W.	¼ E.	¼ W.	½ W.	NE. ¼ E.	27.6	18.5		20.5		
S. by W.	½ W.	0	¼ E.	¼ W.	S. ¾ W.	31.5		31.2		4.6	
ENE.	½ W.	¼ E.	½ W.	¾ W.	NE. by E. ¼ E.	14.2	7.3		12.2		
S. ½ E.	½ W.	0	½ E.	0	S. ½ E.	11.0		11.0	0.5		
NE. ½ N.	½ W.	¼ E.	¼ W.	½ W.	NE. by N.	87.0	72.3		48.3		
							99.4	42.2	82.1	4.6	
Made good,					NE. ¾ E.	96.5	57.2		77.5		97.0

	Latitude.		Longitude.
Point of departure,	36° 55′.6 N.		76° 00′.5 W.
Run,	57 .2 N.	Mid. L., 37°	1 37 .0 E.
By D. R.	37 52 .8 N.		74 23 .5 W.

Example: A steamer's position by observation at noon, patent log reading 27.3, is Lat. 49° 15′ N., Long. 7° 32′ W. Thence she steers 262° (per compass), the total compass error on that course being 20° W., until 12.30, at which time, patent log reading 33.9, the course is changed to 260° (*p. c.*), same error. At 4.12, patent log 80.5, sights are taken from which it is found that the true longitude is 8° 46′ W., and the compass error 19° W. At 6.15, patent log reading 6.1, a sight is taken from which it is found that the true latitude is 48° 34′ 30″ N. At 8 p. m. the patent log reads 27.5. Required the positions by D. R. at each sight and at 8 o'clock.

Time.	Comp. course.	Error.	True course.	Pat. Log.	Dist.	S.	W.	D. Lo.
Noon.				27.3				
12.30	262°	20° W.	242°	33.9	6.6	3.1	5.8	
4.12	260°	20° W.	240°	80.5	46.6	23.3	40.3	
						26.4	46.1	70.3
6.15	260°	19° W.	241°	6.1	25.6	12.4	22.4	34.1
8.00	260°	19° W.	241°	27.5	21.4	10.4	18.7	27.9

	Latitude.		Longitude.
By obs. at noon,	49° 15′.0 N.		7° 32′.0 W.
Run to 4.12 sight,	26 .4 S.	Mid. L., 49°	1 10 .3 W.
By D. R. at 4.12 sight,	48 48 .6 N.		8 42 .3 W.
By obs. at 4.12 sight,			8 46 .0 W.
Run to 6.15 sight,	12 .4 S.	Mid. L., 49°	34 .1 W.
By D. R. at 6.15 sight,	48 36 .2 N.		9 20 .1 W.
By obs. at 6.15 sight,	48 34 .5 N.		
Run to 8 p. m.,	10 .4 S.	Mid. L., 48°	27 .9 W.
By D. R. at 8 p. m.,	48 24 .1 N.		9 48 .0 W.

206. Allowance for Current.—When a vessel is sailing in a known current whose strength may be estimated with a fair degree of accuracy, a more correct position may be arrived at by regarding the set and drift of the current as a course and distance to be regularly taken account of in the dead reckoning.

Example: A vessel in the Gulf Stream at a point where the current is estimated to set 48° at the rate of 1.8 miles an hour, sails 183° (true), making 9.5 knots an hour through the water for $3^h\,30^m$. Middle latitude 35°. Required the course and distance made good.

	True course.	Dist.	N.	S.	E.	W.	D. Lo.
Run	183°	33.3		33.3		1.7	
Current	48°	6.3	4.2		4.7		
Made good	174°	29.3		29.1	3.0		3.6

207. Finding the Current.—It is usual, upon obtaining a good position by observation (as the navigator usually does at noon), to compare that position with the one obtained by dead reckoning, and to attribute such discrepancy as may be found to the effects of current. It has already been pointed out that other causes than the motion of the water tend to make the dead reckoning inaccurate, so that it must not be assumed that currents proper are thus determined with complete correctness.

Current is said to have *set* and *drift*, referring respectively to the direction toward which it is flowing and the velocity with which it moves.

It is evident that, in calculating current by the method of comparing positions by observation with those by account, the navigator must limit himself to the periods during which the dead reckoning has been brought forward independently, without receiving any corrections due to new points of departure. In case it is desired to find the current covering a period during which fresh departures have been used, as from noon to noon, find the algebraical sums of all the differences of latitude and longitude from the table, and apply these to the latitude and longitude of original departure—that of the preceding noon; this gives the position from the ship's run proper, and the difference between this and the position by observation gives the set and drift for the twenty-four hours; if an allowance has been made for current, as explained in the preceding article, that must be omitted in bringing up the position which is to take account of the run only.

208. Day's Run.—It is usual to calculate, each day at noon, the ship's total run for the preceding twenty-four hours. Having the positions at noon of each day, the course and distance between them is found as explained in article 175, Chapter V. The position by observation is used in each case, if such has been found; otherwise, the position by dead reckoning.

Example: At noon, January 22, the position of a vessel by observation was Lat. 35° 10′ N., Long. 134° 01′ W. During the next 24 hours, the run by account was 60.1 miles north and 153.2 miles east. At noon, January 23, the position by observation was Lat. 36° 03′ N., Long. 131° 14′ W. Required the position by D. R. at the latter time; also the run and current for the 24 hours.

	Latitude.		*Longitude.*
By obs., noon, 22d,	35° 10′.0 N.	Mid. L., 36°	134° 01′.0 W.
Run,	1 00 .1 N.	Dep., 153.2 E.	3 09 .4 E.
By D. R., noon, 23d,	36 10 .1 N.	D.Lo., 189.4 E.	130 51 .6 W.
By obs., noon, 23d,	36 03 .0 N.	D.Lo., 22.4 W.	131 14 .0 W.
Current,	6 .9 S.	Dep., 18.1 W.	22.4 W.

Current for 24 hours, 6.9 S., 18.1 W.=249°, 19.4 miles.
Current per hour, 249°, 0.8 mile.

	Latitude.		*Longitude.*
By obs., noon, 23d,	36° 03′.0 N.	Mid. L., 36°	131° 14′.0 W.
By obs., noon, 22d,	35 10 .0 N.	D.Lo., 167. 0E.	134 01.0 W.
Run,	0 53 .0 N.	Dep., 135.1	2 47 .0 E.

Run for 24 hours, 53.0 N., 135.1 E.=68°, 146 miles.

CHAPTER VII.

DEFINITIONS RELATING TO NAUTICAL ASTRONOMY.

209. *Nautical Astronomy*, or *Celo-Navigation*, has been defined (art. 3, Chap. I) as that branch of the science of Navigation in which the position of a ship is determined by the aid of celestial objects—the sun, moon, planets, or stars.

210. THE CELESTIAL SPHERE.—An observer upon the surface of the earth appears to view the heavenly bodies as if they were situated upon the surface of a vast hollow sphere, of which his eye is the center. In reality we know that this apparent vault has no existence, and that we can determine only the relative directions of the heavenly bodies—not their distances from each other or from the observer. But by adopting an imaginary spherical surface of an infinite radius, the eye of the observer being at the center, the places of the heavenly bodies can be projected upon this *Celestial Sphere*, or *Celestial Concave*, at points where the lines joining them with the center intersect the surface of the sphere. Since, however, the center of the earth should be the point from which all angular distances are measured, the observer, by transferring himself there, will find projected on the celestial sphere, not only the heavenly bodies, but the imaginary points and circles of the earth's surface. The actual position of the observer on the surface will be projected in a point called the *zenith;* the meridians, equator, and all other lines and points may also be projected.

211. An observer on the earth's surface is constantly changing his position with relation to the celestial bodies projected on the sphere, thus giving to the latter an apparent motion. This is due to three causes: First, the diurnal motion of the earth, arising from its rotation upon its axis; second, the annual motion of the earth, arising from its motion about the sun in its orbit; and third, the actual motion of certain of the celestial bodies themselves. The changes produced by the diurnal motion are different for observers at different points upon the earth, and therefore depend upon the latitude and longitude of the observer. But the changes arising from the other causes named are independent of the observer's position, and may therefore be considered at any instant in their relation to the center of the earth. To this end the elements necessary for any calculation are tabulated in the *Nautical Almanac* from data based upon laws which have been found by long series of observations to govern the actual and apparent motion of the various bodies.

212. The *Zenith* of an observer on the earth's surface is the point of the celestial sphere vertically overhead. The *Nadir* is the point vertically beneath.

213. The *Celestial Horizon* is the great circle of the celestial sphere formed by passing a plane through the center of the earth at right angles to the line which joins that point with the zenith of the observer. The celestial horizon differs somewhat from the *Visible Horizon*, which is that line appearing to an observer at sea to mark the intersection of earth and sky. This difference arises from two causes: First, the eye of the observer is always elevated above the sea level, thus permitting him a range of vision exceeding 90° from the zenith; and second, the observer's position is on the surface instead of at the center of the earth. These causes give rise, respectively, to *dip of the horizon* and *parallax*, which will be explained later (Chap. X).

214. In figure 29 the celestial sphere is considered to be projected upon the celestial horizon, represented by NESW.; the zenith of the observer is projected at Z, and that pole of the earth which is elevated above the horizon, assumed for illustration to be the north pole, appears at P, the *Elevated Pole* of the celestial sphere. The other pole is not shown in the figure.

215. The *Equinoctial*, or *Celestial Equator*, is the great circle formed by extending the plane of the earth's equator until it intersects the celestial sphere. It is shown in the figure in the line EQW. The equinoctial intersects the horizon in E and W, its east and west points.

216. *Hour Circles, Declination Circles*, or *Celestial Meridians* are great circles of the celestial sphere passing through the poles; they are therefore secondary to the equinoctial, and may be formed by extending the planes of the respective terrestrial meridians until they intersect the celestial sphere. In the figure, PB, PS, PB′, are hour circles, and that one, PS, which contains the zenith and is therefore formed by the extension of the terrestrial meridian of the observer, intersects the horizon in N and S, its north and south points.

217. *Vertical Circles*, or *Circles of Altitude*, are great circles of the celestial sphere which pass through the zenith and nadir; they are therefore secondary to the horizon. In the figure, ZH, WZE, NZS, are projections of such circles, which being at right angles to the plane of projection, appear as straight lines. The vertical circle NZS, which passes through the poles, coincides with the meridian of the observer. The vertical circle WZE, whose plane is at right angles to that of the meridian, intersects the horizon in its eastern and western points, and, therefore, at the points of intersection of the equinoctial; this circle is distinguished as the *Prime Vertical.*

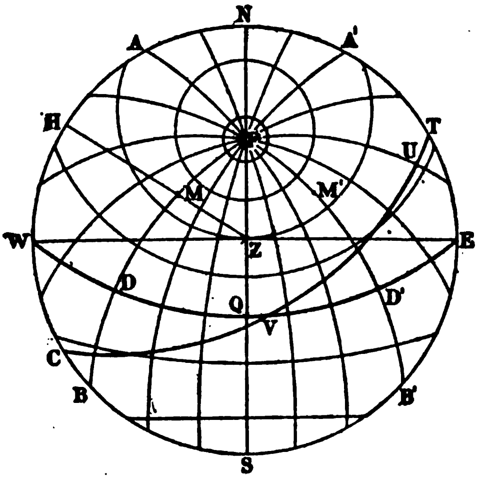

FIG. 29.

218. The *Declination* of any point in the celestial sphere is its angular distance from the equinoctial, measured upon the hour or declination circle which passes through that point; it is designated as *North* or *South* according to the direction of the point from the equinoctial; it is customary to regard north declinations as positive (+), and south declinations as negative (−). In the figure, DM is the declination of the point M. Declination upon the celestial sphere corresponds with latitude upon the earth.

219. The *Polar Distance* of any point is its angular distance from the pole (generally, the elevated pole of an observer), measured upon the hour or declination circle passing through the point; it must therefore equal 90° *minus* the declination, if measured from the pole of the same name as the declination, or 90° *plus* the declination, if measured from the pole of opposite name. The polar distance of the point M from the elevated pole P is PM.

220. The *Altitude* of any point in the celestial sphere is its angular distance from the horizon, measured upon the vertical circle passing through the point; it is regarded as positive when the body is on the same side of the horizon as the zenith. The altitude of the point M is HM.

221. The *Zenith Distance* of any point is its angular distance from the zenith, measured upon the vertical circle passing through the point; the zenith distance of any point which is above the horizon of an observer must therefore equal 90° *minus* the altitude. The zenith distance of M, in the figure, is ZM.

222. The *Hour Angle* of any point is the angle at the pole between the meridian of the observer and the hour circle passing through that point; it may also be regarded as the arc of the equinoctial intercepted between those circles. It is measured toward the west as a positive direction through the twenty-four hours, or 360 degrees, which constitute the interval between the successive returns to the meridian, due to the diurnal rotation of the earth, of any point in the celestial sphere. The hour angle of M is the angle QPD, or the arc QD.

223. The *Azimuth* of a point in the celestial sphere is the angle at the zenith between the meridian of the observer and the vertical circle passing through the point; it may also be regarded as the arc of the horizon intercepted between those circles. It is measured from either the north or the south point of the horizon (usually that one of the same name as the elevated pole) to the east or west through 180°, and is named accordingly; as, N. 60° W., or S. 120° W. The azimuth of M is the angle NZH, or the arc NH, from the north point, or the angle SZH, or the arc SH, from the south point of the horizon.

224. The *Amplitude* of a point is the angle at the zenith between the prime vertical and the vertical circle of the point; it is measured from the east or the west point of the horizon through 90°, as W. 30° N. It is closely allied with the azimuth and may always be deduced therefrom. In the figure, the amplitude of H is the angle WZH, or the arc WH. The amplitude is only used with reference to points in the horizon.

225. The *Ecliptic* is the great circle representing the path in which, by reason of the annual revolution of the earth, the sun appears to move in the celestial sphere; the plane of the ecliptic is inclined to that of the equinoctial at an angle of 23° 27½′, and this inclination is called the *obliquity of the ecliptic*. The ecliptic is represented by the great circle CVT.

226. The *Equinoxes* are those points at which the ecliptic and the equinoctial intersect, and when the sun occupies either of these positions the days and nights are of equal length throughout the earth. The *Vernal Equinox* is that one at which the sun appears to an observer on the earth when passing from southern to northern declination, and the *Autumnal Equinox* that one at which it appears when passing from northern to southern declination. The Vernal Equinox is also designated as the *First Point of Aries*, and is used as an origin for reckoning right ascension; it is indicated in the figure at V.

227. The *Solstitial Points*, or *Solstices*, are points of the ecliptic at a distance of 90° from the equinoxes, at which the sun attains its highest declination in each hemisphere. They are called respectively the *Summer* and the *Winter Solstice*, according to the season in which the sun appears to pass these points in its path. The Summer Solstice is indicated in the figure at U.

228. The *Right Ascension* of a point is the angle at the pole between the hour circle of the point and that of the First Point of Aries; it may also be regarded as the arc of the equinoctial intercepted between those circles. It is measured from the First Point of Aries to the eastward as a positive direction, through twenty-four hours or 360 degrees. The right ascension of the point M′ is VD′.

229. *Celestial Latitude* is measured to the north or south of the ecliptic upon great circles secondary thereto. *Celestial Longitude* is measured upon the ecliptic from the First Point of Aries as an origin, being regarded as positive to the eastward throughout 360°.

230. COORDINATES.—In order to define the position of a point in space, a system of lines, angles, or planes, or a combination of these, is used to refer it to some fixed line or plane adopted as the primitive; and the lines, angles, or planes by which it is thus referred are called *coordinates*.

231. In figure 30 is shown a system of rectilinear coordinates for a plane. A fixed line FE is chosen, and in it a definite point C, as the *origin*. Then the position of a point A is defined by CB $=x$, the distance from the origin, C, to the foot of a perpendicular let fall from A on FE; and by AB $=y$, the length of the perpendicular. The distance x is called the *abscissa* and y the *ordinate*. Assuming two intersecting right lines FE and HI as standard lines of reference, the location of the point A is defined by regarding the distances measured to the right hand of HI and above FE as *positive;* those to the left hand of HI and below FE as *negative*.

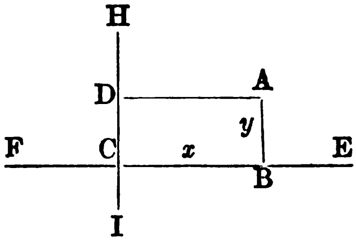

FIG. 30.

An exemplification of this system is found in the chart, on which FE is represented by the equator, HI by the prime meridian; the coordinates x and y being the longitude and latitude of the point A.

232. The great circle is to the sphere what the straight line is to the plane; hence, in order to define the position of a point on the surface of a sphere, some great circle must be selected as the primary, and some particular point of it as the origin. Thus, in figure 31, which represents the case of a sphere, some fixed great circle, CBQ, is selected as the axis and called the *primary;* and a point C is chosen as the origin. Then to define the position of any point A, the abscissa x equals the distance from C to the point B, where the secondary great circle through A intersects the primary; the ordinate y equals the distance of A from the primary measured on the secondary—that is, $x = \text{CB}$ and $y = \text{AB}$.

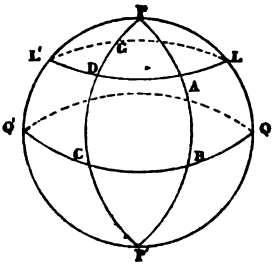

FIG. 31.

233. In the case of the earth, the primary selected is the equator (its plane being perpendicular to the earth's axis), and upon this are measured the abscissæ, while upon the secondaries to it are measured the ordinates of all points on the earth's surface. The initial point for reference on the equator is determined by the *prime meridian* chosen, West longitudes and North latitudes being called *positive*, East longitudes and South latitudes, *negative*.

234. In the case of the celestial sphere, there are four systems of coordinates in use for defining the position of any point; these vary according to the circle adopted as the primary and the point used as an origin. They are as follows:

1. Altitude and azimuth.
2. Declination and hour angle.
3. Declination and right ascension.
4. Celestial latitude and longitude.

235. In the system of *Altitude and Azimuth*, the primary circle is the celestial horizon, the secondaries to which are the vertical circles, or circles of altitude. The horizon is intersected by the celestial meridian in its northern and southern points, of which one—usually that adjacent to the elevated pole—is selected as an origin for reckoning coordinates. The azimuth indicates in which vertical circle the point to be defined is found, and the altitude gives the position of the point in that circle. In figure 29 the point M is located, according to this system, by its azimuth NH and altitude HM.

236. In the system of *Declination and Hour Angle*, the primary circle is the equinoctial, the secondaries to which are the circles of declination, or hour circles. The point of origin is that point of intersection of the equinoctial and celestial meridian which is above the horizon. The hour angle indicates in which declination circle the point to be defined is found, and the declination gives the position of the point in that circle. In figure 29 the point M is located, according to this system, by its hour angle QD and declination DM.

237. In the system of *Declination and Right Ascension*, the primary and secondaries are the same as in the system just described, but the point of origin differs, being assumed to be at the First Point of Aries, or vernal equinox. The right ascension indicates in which declination circle the point to be defined may be found, and the declination gives the position in that circle. In figure 29 the point M′ is located by VD′, the right ascension, and D′M′, the declination. It should be noted that this system differs from the preceding in that the position of a point is herein referred to a fixed point in the celestial sphere and is independent of the zenith of the observer as well as of the position of the earth in its diurnal motion, while, in the system of declination and hour angle, both of these are factors in determining the coordinates.

238. In the system of *Celestial Latitude and Longitude*, the primary circle is the ecliptic; the point of origin, the First Point of Aries. The method of reckoning by this system, which is of only slight importance in Nautical Astronomy, will appear from the definitions of celestial latitude and longitude already given (art. 229).

CHAPTER VIII.

INSTRUMENTS EMPLOYED IN NAUTICAL ASTRONOMY.

THE SEXTANT.

239. The *sextant* is an instrument for measuring the angle between two objects by bringing into coincidence at the eye of the observer rays of light received directly from the one and by reflection from the other, the measure being afforded by the inclination of the reflecting surfaces. By reason of its small dimensions, its accuracy, and, above all, the fact that it does not require a permanent or a stable mounting but is available for use under the conditions existing on shipboard, it is a most important instrument for the purposes of the navigator. While the sextant is not capable of the same degree of accuracy as fixed instruments, its measurements are sufficiently exact for navigation.

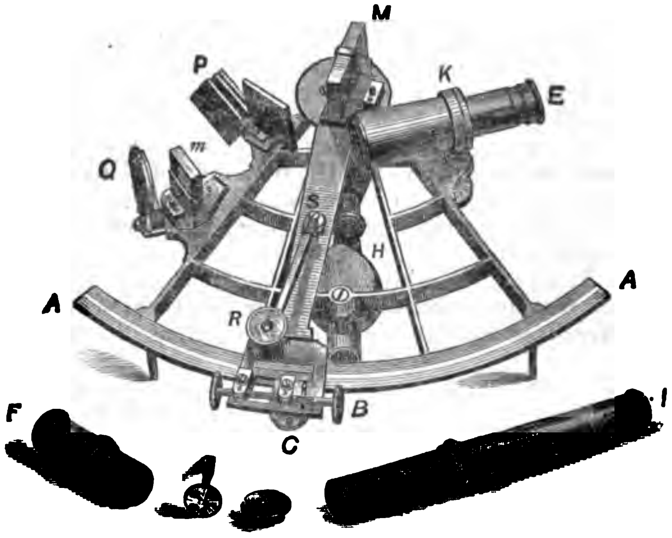

FIG. 32.

240. DESCRIPTION.—A usual form of the sextant is represented in figure 32. The frame is of brass or some similar alloy. The graduated arc, AA, generally of silver, is marked in appropriate divisions; in the finer sextants, each division represents 10′, and the vernier affords a means of reading to 10″. A wooden handle, H, is provided for holding the instrument. The *index mirror*, M, and *horizon mirror*, *m*, are of plate glass, and are silvered, though the upper half of the horizon glass is left plain to allow direct rays to pass through unobstructed. To give greater distinctness to the images, a small *telescope*, E, is placed in the line of sight; it is supported in a ring, K, which can be moved by a screw in a direction at right angles to the plane of the sextant, thus shifting the axis of the telescope, and therefore the plane of reflection; this plane, however, always remains parallel to that of the instrument, the motion of the telescope being intended merely to regulate the relative brightness of the direct and reflected image. In the ring, K, are small screws for the purpose of adjusting the telescope by making its axis parallel with the plane of the sextant. The vernier is carried on the end of an index bar pivoted beneath the index mirror, M, and thus travels along the graduated scale, affording a measure for any change of inclination of the index mirror; a reading glass, R, attached to the index bar and turning upon a pivot, S, facilitates the reading of vernier and scale. The index mirror, M, is attached to the head of the index bar, with its surface perpendicular to the plane of the instrument; an adjusting screw is fitted at the back to permit of adjustment to the perpendicular plane. The fixed glass *m*, half silvered and half plain, is called the *horizon glass*, as it is through this that the horizon is observed in measuring altitudes of celestial bodies; it is provided with screws, by which its perpendicularity to the plane of the instrument may be adjusted. At P and Q are colored glasses of different shades, which may be used separately or in combination to protect the eye from the intense light of the sun. In order to observe with accuracy and make the images come precisely in contact, a *tangent screw*, B, is fixed to the index, by means of which the latter may be moved with greater precision than by hand; but this screw does not act until the index is fixed by the screw C at the back of the sextant; when the index is to be moved any considerable amount, the screw C is loosened; when it is brought near to its required position the screw must be tightened, and the index may then be moved gradually by the tangent screw.

Besides the telescope, E, the instrument is usually provided with an inverting telescope, I, and a tube without glasses, F; also, with a cap carrying colored glasses, which may be put on the eye end of the telescope, thus dispensing with the necessity for the use of the colored shades, P and Q, and eliminating any possible errors which might arise from nonparallelism of their surfaces.

The latest type of sextant furnished to the United States Navy is fitted with an endless tangent screw which carries a micrometer drum from which the seconds of arc are read. By pressure of the thumb the tangent screw is released and the index bar may be moved to any position on the arc by hand, where the tangent screw is again thrown into gear by releasing the pressure of the thumb. The endless tangent screw is accomplished by cutting the edge of the arc with the worm teeth into which the tangent screw gears. At night the reading of this sextant is facilitated by a small electric light carried on it and supplied by a battery contained in the handle.

241. The *vernier* is an attachment for facilitating the exact reading of the scale of a sextant, by which aliquot parts of the smallest divisions of the graduated scale are measured. The principle of the sextant vernier is identical with that of the barometer vernier, a complete description of which will be found in article 52, Chapter II. The arc of a sextant is usually divided into 120 or more parts, each division representing 1°; each of these degree divisions is further subdivided to an extent dependent upon the accuracy of reading of which the sextant is capable. In the instruments for finer work, the divisions of the scale correspond to 10′ each, and the vernier covers a length corresponding to 59 such divisions, which is subdivided into 60 parts, thus permitting a reading of 10″; all sextants, however, are not so closely graduated.

Whatever the limits of subdivision, all sextants are fitted with verniers which contain one more division than the length of scale covered, and in which, therefore, scale-readings and vernier-readings increase in the same direction—toward the left hand. To read any sextant, it is merely necessary to observe the scale division next below, or to the right of, the zero of the vernier, and to add thereto the angle corresponding to that division of the vernier scale which is most nearly in exact coincidence with a division of the instrument scale.

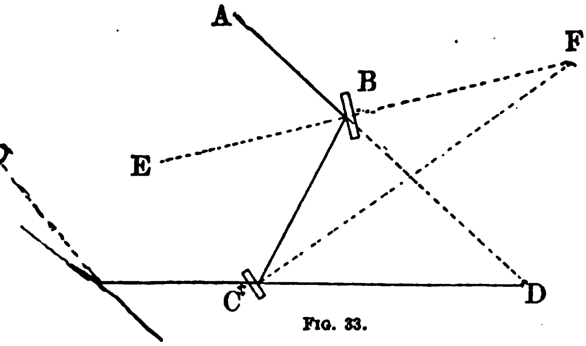

Fig. 33.

242. Optical Principle.—When a ray of light is reflected from a plane surface, the angle of incidence is equal to the angle of reflection. From this it may be proved that when a ray of light undergoes two reflections in the same plane the angle between its first and its last direction is equal to twice the inclination of the reflecting surfaces. Upon this fact the construction of the sextant is based.

In figure 33, let B and C represent respectively the index mirror and horizon mirror of a sextant; draw EF perpendicular to B, and CF perpendicular to C; then the angle CFB represents the inclination of the two mirrors. Suppose a ray to proceed from A and undergo reflection at B and at C, its last direction being CD; then ADC is the angle between its first and last directions, and we desire to prove that ADC = 2 CFB.

From the equality of the angles of incidence and reflection:

$$\text{ABE}=\text{EBC, and ABC}=2\ \text{EBC};$$
$$\text{BCF}=\text{FCD, and BCD}=2\ \text{BCF}.$$

From Geometry:

$$\text{ADC}=\text{ABC}-\text{BCD}=2\ (\text{EBC}-\text{BCF})=2\ \text{CFB},$$

which is the relation that was to be proved.

243. In the sextant, since the index mirror is immovably attached to the index arm, which also carries the vernier, it follows that no change can occur in the inclination between the index mirror and the horizon mirror, excepting such as is registered by the travel of the vernier upon the scale.

If, when the index mirror is so placed that it is nearly parallel with the horizon mirror, an observer direct the telescope toward some well-defined object, there will be seen in the field of view two separate images of the object; and if the inclination of the index mirror be slightly changed by moving the index bar, it will be seen that while one of the images remains fixed the other moves. The fixed image is the direct one seen through the unsilvered part of the horizon glass, while the movable image is due to rays reflected by the index and horizon mirrors. When the two images coincide these mirrors must be parallel (assuming that the object is sufficiently distant to disregard the space which separates the mirrors; in this position of the index mirror the vernier indicates the true zero of the scale. If, however, instead of observing a single object, the instrument is so placed that the direct ray from one object appears in coincidence with the reflected ray of a second object, then the true angle between the objects will be twice the angle of inclination between the mirrors, or twice the angle measured by the vernier from the true zero of the scale. To avoid the necessity of doubling the angle on the scale, the latter is so marked that each half degree appears as a whole degree, whence its indications give the whole angle directly.

244. ADJUSTMENTS OF THE SEXTANT.—The theory of the sextant requires that, for accurate indications, the following conditions be fulfilled:

(*a*) The two surfaces of each mirror and shade glass must be parallel planes.

(*b*) The graduated arc or limb must be a plane, and its graduations, as well as those of the vernier, must be exact.

(*c*) The axis must be at the center of the limb, and perpendicular to the plane thereof.

(*d*) The index and horizon glasses must be perpendicular, and the line of sight parallel to the plane of the limb.

Of these, only the last named ordinarily require the attention of the navigator who is to make use of the sextant; the others, which may be called the *permanent adjustments*, should be made before the instrument leaves the hands of the maker, and with careful use will never be deranged.

245. The *Adjustment of the Index Mirror* consists in making the reflecting surface of this mirror truly perpendicular to the plane of the sextant. In order to test this, set the index near the middle of the arc, then, placing the eye very nearly in the plane of the sextant and close to the index mirror, observe whether the direct image of the arc and its image reflected from the mirror appear to form one continuous arc; if so, the glass is perpendicular to the plane of the sextant; if the reflected image appears to droop from the arc seen directly, the glass leans backward; if it seems to rise, the glass leans forward. The adjustment is made by the screws at the back of the mirror.

246. The *Adjustment of the Horizon Mirror* consists in making the reflecting surface of this mirror perpendicular to the plane of the sextant. The index mirror having been adjusted, if, in revolving it by means of the index arm, there is found one position in which it is parallel to the horizon glass, then the latter must also be perpendicular to the plane of the sextant. In order to test this, put in the telescope and direct it toward a star; move the index until the reflected image appears to pass the direct image; if one passes directly over the other the mirrors must be parallel;

if one passes on either side of the other the horizon glass needs adjustment, which is accomplished by means of the screws attached.

The sea horizon may also be used for making this adjustment. Hold the sextant vertically and bring the direct and the reflected images of the horizon line into coincidence; then incline the sextant until its plane makes but a small angle with the horizon; if the images still coincide the glasses are parallel; if not, the horizon glass needs adjustment.

247. The *Adjustment of the Telescope* must be so made that, in measuring angular distances, the line of sight, or axis of the telescope, shall be parallel to the plane of the instrument, as a deviation in that respect, in measuring large angles, will occasion a considerable error. To avoid such error, a telescope is employed in which are placed two wires, parallel to each other and equidistant from the center of the telescope; by means of these wires the adjustment may be made. Screw on the telescope, and turn the tube containing the eyeglass till the wires are parallel to the plane of the instrument; then select two clearly defined objects whose angular distance must be not less than 90°, because an error is more easily discovered when the angle is great; bring the reflected image of one object into exact coincidence with the direct image of the other at the inner wire; then, by altering slightly the position of the instrument, make the objects appear on the other wire; if the contact still remains perfect, the axis of the telescope is in its right situation; but if the two objects appear to separate or lap over at the outer wire the telescope is not parallel, and it must be rectified by turning one of the two screws of the ring into which the telescope is screwed, having previously unturned the other screw; by repeating this operation a few times the contact will be precisely the same at both wires, and the axis of the telescope will be parallel to the plane of the instrument.

Another method of making this adjustment is to place the sextant upon a table in a horizontal position, look along the plane of the limb, and make a mark upon a wall, or other vertical surface, at a distance of about 20 feet; draw another mark above the first at a distance equal to the height of the axis of the telescope above the plane of the limb; then so adjust the telescope that the upper mark, as viewed through the telescope, falls midway between the wires. Some sextants are accompanied by small sights whose height is exactly equal to the distance between the telescope and the plane of the limb; by the use of these, the necessity for employing the second mark is avoided and the adjustment can be very accurately made.

248. The errors which arise from defects in what have been denominated the *permanent adjustments* of the sextant may be divided into three classes, namely: Errors due to faulty centering of the axis, called *eccentricity;* errors of graduation; and errors arising from lack of parallelism of surfaces in index mirror and in shade glasses.

The errors due to eccentricity and faulty graduation are constant for the same angle, and should be determined once for all at some place where proper facilities for doing the work are at hand; these errors can only be ascertained by measuring known angles with the sextant. If angles of 10°, 20°, 30°, 40°, etc., are first laid off with a theodolite or similar instrument and then measured by the sextant, a table of errors of the sextant due to eccentricity and faulty graduation may be made, and the error at any intermediate angle found by interpolation; this table will include the error of graduation of the theodolite and also the error due to inaccurate reading of the sextant, but such errors are small. Another method for determining the combined errors of eccentricity and graduation is by measuring the angular distance between stars and comparing the observed and the computed arc between them, but this process is liable to inaccuracies by reason of the uncertainty of allowances for atmospheric refraction.

Errors of graduation, when large, may be detected by "stepping off" distances on the graduated arc with the vernier; place the zero of the vernier in exact coincidence with a division of the arc, and observe whether the final division of the vernier also coincides with a division of the arc; this should be tried at numerous positions of the graduated limb, and the agreement ought to be perfect in every case.

The error due to a prismatic index mirror may be found by measuring a certain unchangeable angle, then taking out the glass and turning the upper edge down, and measuring the angle again; half the difference of these two measures will be the error at that angle due to the mirror. From a number of measures of angles in this manner, a table similar to the one for eccentricity and faulty graduation can be made; or the two tables may be combined. When possible to avoid it, however, no sextant should be used in which there is an index mirror which produces a greater error than that due to the probable error of reading the scale. Mirrors having a greater angle than 2″ between their faces are rejected for use in the United States Navy. Index mirrors may be roughly tested by noting if there is an elongated image of a well-defined point at large angles.

Since the error due to a prismatic horizon mirror is included in the index correction (art. 249), and consequently applied alike to all angles, it may be neglected.

Errors due to prismatic shade glasses can be determined by measuring angles with and without the shade glasses and noting the difference. They may also be determined, where the glasses are so arranged that they can be turned through an angle of 180°, by measuring the angle first with the glass in its usual position and then reversed, and taking the mean of the two as the true measure.

249. INDEX ERROR.—The *Index Error* of a sextant is the error of its indications due to the fact that when the index and horizon mirrors are parallel the zero of the vernier does not coincide with the zero of the scale. Having made the adjustments of the index and horizon mirrors and of the telescope, as previously described, it is necessary to find that point of the arc at which the zero of the vernier falls when the two mirrors are parallel, for all angles measured by the sextant are reckoned from that point. If this point is to the left of the zero of the limb, all readings will be too great; if to the right of the zero, all readings will be too small.

If desirable that the reading should be zero when the mirrors are parallel, place the zero of the vernier on zero of the arc; then, by means of the adjusting screws of the horizon glass, move that glass until the direct and reflected images of the same object coincide, after which the perpendicularity of the horizon glass should again be verified, as it may have been deranged by the operation. This adjustment is not essential, since the correction may readily be determined and applied to the reading. In certain sextant work, however, such as surveying, it will be very convenient to be relieved of the necessity of correcting each angle observed. The sextant should never be relied upon for maintaining a constant index correction, and the error should be ascertained frequently. It is a good practice to verify the correction each time a sight is taken.

250. The *Index Correction* may be found (*a*) by a star, (*b*) by the sea horizon, and (*c*) by the sun.

(*a*) Bring the direct and reflected images of a star into coincidence, and read off the arc. The index correction is numerically equal to this reading, and is positive or negative according as the reading is on the right or left of the zero.

(*b*) The same method may be employed, substituting for a star the sea horizon, though this will be found somewhat less accurate.

(*c*) Measure the apparent diameter of the sun by first bringing the upper limb of the reflected image to touch the lower limb of the direct image, and then bringing the lower limb of the reflected image to touch the upper limb of the direct image.

Denote the readings in the two cases by r and r'; then, if S = apparent diameter of the sun, and R = the reading of the sextant when the two images are in coincidence, we have:

$$r = R + S,$$
$$r' = R - S,$$
$$R = \tfrac{1}{2}(r + r').$$

As R represents the *error*, the *correction* will be −R. Hence the rule: Mark the readings when *on* the arc with the *negative* sign; when *off*, with the *positive* sign; then the index correction is one-half the algebraic sum of the two readings.

EXAMPLE: The sun's diameter is measured for index correction as follows: On the arc, 31′ 20″; off the arc, 33′ 10″. Required the correction.

On the arc,	−31′	20″
Off the arc,	+33	10
2)+	1	50
I. C.,	+ 0	55

251. From the equations previously given, it is seen that:

$$S = \tfrac{1}{2}(r - r');$$

hence, if the observations are correct, it will be found that the sun's semidiameter, as given in the Nautical Almanac for the day of observation, is equal to one-half the algebraic difference of the readings. If required to obtain the index correction with great precision, several observations should be taken and the mean used, the accuracy being verified by comparing the tabulated with the observed semidiameter. If the sun is low, the horizontal semidiameter should be observed, to prevent the error that may arise from unequal refraction.

252. USE OF THE SEXTANT.—To measure the angle between any two visible objects, point the telescope toward the lower one, if one is above the other, or toward the left-hand one, if they are in nearly the same horizontal plane. Keep this object in direct view through the unsilvered part of the horizon glass, and move the index arm until the image of the other object is seen by a double reflection from the index mirror and the silvered portion of the horizon glass. Having gotten the direct image of one object into nearly exact contact with the reflected image of the other, clamp the index arm and, by means of the tangent screw, complete the adjustment so that the contact may be perfect; then read the limb.

In measuring the altitude of a celestial body above the sea horizon, it is necessary that the angle shall be measured to that point of the horizon which lies vertically beneath the object. To determine this point, the observer should move the instrument slightly to the right and left of the vertical, swinging it about the line of sight as an axis, taking care to keep the object in the middle of the field of view. The object will appear to describe the arc of a circle, and the lowest point of this arc marks the true vertical.

The shade glasses should be employed as may be necessary to protect the eye when observing objects of dazzling brightness, such as the sun, or the horizon when the sun is reflected from it at a low altitude. Care must be taken that the images are not too bright or the eye will be so affected as to interfere with the accuracy of the observations.

253. CHOICE OF SEXTANTS.—The choice of a sextant should be governed by the kind of work which is required to be done. In rough work, such as surveying, where angles need only be measured to the nearest 30″ the radius may be as small as 6 inches, which will permit easy reading, and the instrument can be correspondingly lightened. Where readings to 10″ are desired, as in nice astronomical work, the radius should be about 7½ inches, and the instrument, to be strongly built, should weigh about 3½ pounds.

The parts of an instrument should move freely, without binding or gritting. The eyepieces should move easily in the telescope tubes; the bracket for carrying the telescope should be made very strong. It is frequently found that the parallelism of the line of sight is destroyed in focusing the eyepiece, either on account of the looseness of the fit or because of the telescope bracket being weak. The vernier should lie close to the limbs to prevent parallax in reading. If it is either too loose or too tight at either extremity of its travel, it may indicate that the pivot is not perpendicular. The balls of the tangent screw should fit snugly in their sockets, so that there may be no lost motion.

Where possible, the sextant should always be submitted to expert examination and test as to the accuracy of its permanent adjustments before acceptance by the navigator.

254. RESILVERING MIRRORS.—Occasion may sometimes arise for resilvering the mirrors of a sextant, as they are always liable to be damaged by dampness or other causes. For this purpose some clean tin foil and mercury are required. Upon a piece of glass about 4 inches square lay a piece of tin foil whose dimensions exceed by about a quarter of an inch in each direction those of the glass to be silvered; smooth out the foil carefully by rubbing; put a small drop of mercury on the foil and spread it with the finger over the entire surface, being careful that none shall find its way under the foil; then put on a few more drops of mercury until the whole surface is fluid. The glass which is to be silvered having been carefully cleaned, it should be laid upon a piece of tissue paper whose edge just covers the edge of the foil and transferred carefully from the paper to the tin foil, a gentle pressure being kept upon the glass to avoid the formation of bubbles; finally, place the mirror face downward and leave it in an inclined position to allow the surplus mercury to flow off, the latter operation being hastened by a strip of tin foil at its lower edge. After five or six hours the tin foil around the edges may be removed, and the next day a coat of varnish made from spirits of wine and red sealing wax should be applied. For a horizon mirror care must be taken to avoid silvering the plain half. The mercury drawn from the foil should not be placed with clean mercury with a view to use in the artificial horizon or the whole will be spoiled.

255. Octants and Quintants.—Properly speaking, a sextant is an instrument whose arc covers one-sixth of a complete circle, and which is therefore capable of measuring an angle of 120°. Other instruments are made which are identical in principle with the sextant as heretofore described, and which differ from that instrument only in the length of the arc. These are the *octant*, an eighth of a circle, by which angles may be measured to 90°, and the *quintant*, a fifth of a circle, which measures angles up to 144°. The distinction between these instruments is not always carefully made, and in such matters as have been touched upon in the foregoing articles the sextant may be regarded as the type of all kindred reflecting instruments.

THE ARTIFICIAL HORIZON.

256. The *Artificial Horizon* is a small, rectangular, shallow basin of mercury, over which, to protect the mercury from agitation by the wind, is placed a roof consisting of two plates of glass at right angles to each other. The mercury affords a perfectly horizontal surface which is at the same time an excellent mirror. The different parts of an artificial horizon are furnished in a compact form, a metal bottle being provided for containing the mercury when not in use, together with a suitable funnel for pouring.

If MN, in figure 34, is the horizontal surface of the mercury; S′B a ray of light from a celestial object, incident to the surface at B; BA the reflected ray; then an observer at A will receive the ray BA as if it proceeded from a point S″, whose angular depression, MBS″, below the horizontal plane is equal to the altitude, MBS′, of the object above that plane. If, then, SA is a direct ray from the object parallel to S′B, an observer at A can measure with the sextant the angle SAS″ = S′BS″ = 2 S′BM, by bringing the image of the object reflected by the index mirror into coincidence with the image S″ reflected by the mercury and seen through the horizon glass. The instrumental measure, corrected for index error, will be double the apparent altitude of the body.

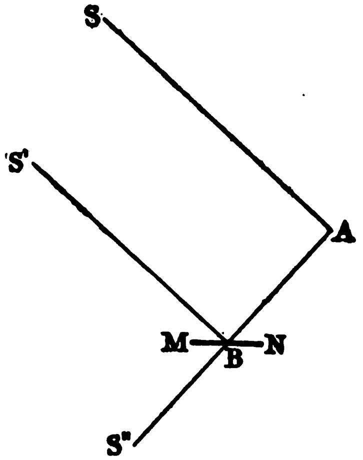

Fig. 34.

The sun's altitude will be measured by bringing the lower limb of one image to touch the upper limb of the other. Half the corrected instrumental reading will be the apparent altitude of the sun's *lower* or *upper* limb, according as the lower or upper limb of the *reflected* image was the one employed in the observation.

In observations of the sun with the artificial horizon, the eye is protected by a single dark glass over the eyepiece of the telescope through which direct and reflected rays must pass alike, thereby avoiding the errors that might possibly arise from a difference in the separate shade glasses attached to the frame of the sextant.

The glasses in the roof over the mercury should be made of plate glass, with perfectly parallel faces. If they are at all prismatic, the observed altitude will be erroneous. The error may be removed by observing a second altitude with the roof reversed, and, in general, by taking one-half of a set of observations with the roof in one position and the other half with the roof reversed. On the rare occasions when the atmosphere is so calm that the unsheltered mercury will remain undisturbed, most satisfactory observations may be made by leaving off the roof.

257. In setting up an artificial horizon, care should be taken that the basin is free from dust and other foreign matter, as small particles floating upon the surface of the mercury interfere with a perfect reflection. The basin should be so placed that its longer edge lies in the direction in which the observed body will bear at the middle of the observations. The spot selected for taking the sights should be as free as possible from causes which will produce vibration of the mercury, and precautions should be taken to shelter the horizon from the wind, as the mere placing of the roof will not ordinarily be sufficient to accomplish this. Embedding the roof in earth serves to keep out the wind, while setting the whole horizon upon a thick towel or a piece of such material as heavy felt usually affords ample protection from wind, tends to reduce the vibrations from mechanical shocks, and also aids in keeping out the moisture from the ground. In damp climates the roof should be kept dry by wiping, or the moisture deposited from the inclosed air will form a cloud upon the glass.

Molasses, oil, or other viscous fluid may, when necessary, be employed as a substitute for mercury.

258. Owing to the perfection of manufacture that is required to insure accuracy of results with the artificial horizon, navigators are advised to accept only such instrument as has satisfactorily stood the necessary tests to prove the correctness of its adjustment as regards the glasses of the roof.

THE CHRONOMETER.

259. The *Chronometer* is simply a correct time measurer, differing from an ordinary watch in having the force of its mainspring rendered uniform by means of a variable lever. Owing to the fact that on a sea voyage a chronometer is exposed to many changes of temperature, it is furnished with an expansion balance, formed of a combination of metals of different expansive qualities, which produces the required compensation. In order that its working may not be deranged by the motion of the ship in a seaway, the instrument is carried in gimbals.

As the regularity of the chronometer is essential for the correct determination of a ship's position, it is of the greatest importance that every precaution be taken to insure the accuracy of its indications. There is no more certain way of doing this than to provide a vessel with several of these instruments—preferably not less than three—in order that if an irregularity develop in one, the fact may be revealed by the others.

260. Care of Chronometers on Shipboard.—The box in which the chronometers are kept should have a permanent place as near as practicable to the center of motion of the ship, and where it will be free from excessive shocks and jars, such as those that arise from the engines or from the firing of heavy guns; the location should be one free from sudden and extreme changes of temperature, and as far removed as possible from masses of vertical iron. The box should contain a separate compartment for each chronometer, and each compartment should be lined with baize cloth padded with curled hair, for the double purpose of reducing shocks and equalizing the temperature within. An outer cover of baize cloth should be provided for the box, and this should be changed or dried out frequently in damp weather. The chronometers should all be placed with the XII mark in the same position.

For transportation for short distances by hand, an instrument should be rigidly clamped in its gimbals, for if left free to swing, its performance may be deranged by the violent oscillations that are imparted to it.

For transportation for a considerable distance, as by express, the chronometer should be allowed to run down, and should then be dismounted and the balance corked.

261. Since it is not possible to make a perfect instrument which will be uninfluenced by the disturbing causes incident to a sea voyage, it becomes the duty of the navigator to determine the *error* and to keep watch upon the variable *rate* of the chronometer.

The *error of the chronometer* is the difference between the time indicated and the standard time to which it is referred—usually Greenwich mean time.

The amount the chronometer *gains* or *loses* daily is the *daily rate*.

The indications of a chronometer at any given instant require a correction for the accumulated error to that instant; and this can be found if the error at any given time, together with the daily rate, are known.

262. Winding.—Chronometers are ordinarily constructed to run for 56 hours without rewinding, and an indicator on the face always shows how many hours have elapsed since the last winding. To insure a uniform rate, they must be wound regularly every day, and, in order to avoid the serious consequences of their running down, the navigator should take some means to guard against neglecting this duty through a fault of memory. To wind, turn the chronometer gently on its side, enter the key in its hole and push it home, steadying the instrument with the hand, and wind to the left, the last half turn being made so as to bring up gently against the stop. After winding, cover the keyhole and return the instrument to its natural position. Chronometers should always be wound in the same order to prevent omissions, and the precaution taken to inspect the indicators, as a further assurance of the proper performance of the operation.

After winding each day, the comparisons should be made, and, with the readings of the maximum-and-minimum thermometer and other necessary data, recorded in a book kept for the purpose.

The maximum-and-minimum thermometer is one so arranged that its highest and lowest readings are marked by small steel indices that remain in place until reset. Every chronometer box should be provided with such an instrument, as a knowledge of the temperature to which chronometers have been subjected is essential in any analysis of the rate. To draw down the indices for the purpose of resetting, a magnet is used. This magnet should be kept at all times at a distance from the chronometers.

263. Comparison of Chronometers.—The instrument believed to be the best is regarded as the *Standard*, and each other is compared with it. It is usual to designate the Standard as A, and the others as B, C, etc. Chronometers are made to beat half seconds, and any two may be compared by following the beat of one with the ear and of the other with the eye.

To make a comparison, say of A and B, open the boxes of these two instruments and close all others. Get the cadence and, commencing when A has just completed the beat of some even 5-second division of the dial, count "half-one-half-two-half-three-half-four-half-five," glancing at B in time to note the position of its second hand at the last count; the seconds indicated by A will be five greater than the number at the beginning of the count. The hours and minutes are also recorded for each chronometer, and the subtraction made. A good check upon the accuracy is afforded by repeating the operation, taking the tick from B.

Where necessary for exact work, it is possible to estimate the fraction between beats, and thus make the comparison to tenths of a second; but the nearest half second is sufficiently exact for the purposes of ordinary navigation at sea.

264. The following form represents a convenient method of recording comparisons:

Stand. A, No. 777. Chro. B, No. 1509. Chro. C, No. 1802.

Date, 1903.	Designation of comparisons.	Chro. B with Stand. A.	2d diff.	Chro. C with Stand. A.	2d diff.	Therm.			Bar.	Remarks.
						Max.	Min.	Air.		
		h. m. s.	s.	h. m. s.	s.	°	°	°	"	
January 1	Stand. A. B and C.	1 13 40 1 12 21.5		1 14 20 2 04 11		63	59	60	30.07	Found errors by time-ball.
	Difference.	1 18.5	—	11 10 09	—					
2	Stand. A. B and C.	1 16 30 1 15 10		1 17 00 2 06 51.5		64	58	57	30.12	Left New York for San Juan, P. R.
	Difference.	1 20	+1.5	11 10 08.5	−0.5					

265. The *second difference* in the form is the difference between the comparisons of the same instruments for two successive days. When a vessel is equipped with only one chronometer there is nothing to indicate any irregularity that it may develop at sea—and even the best instruments may undergo changes from no apparent cause. When there are two chronometers, the second difference, which is equal to the algebraic difference between their daily rates, remains uniform as long as the rates remain uniform, but changes if one of the rates undergoes a change; in such a case, there is no means of knowing which chronometer has departed from its expected performance, and the navigator must proceed with caution, giving due faith to the indications of each. If, however, there are three chronometers, an irregularity on the part of one is at once located by a comparison of the second differences. Thus, if the predicted rates of the chronometers were such as to give for the second difference of A − B, $+1^s.5$, and of A − C, $-0^s.5$, suppose on a certain day those differences were $+4^s.5$ and $-0^s.5$, respectively; it would at once be suspected that the irregularity was in B, and that that chronometer had lost 3^s on its normal rate during the preceding day. Suppose, however, the second differences were $+4^s.5$ and $+2^s.5$; it would then be apparent that A had gained 3^s.

266. TEMPERATURE CURVES.—Notwithstanding the care taken to eliminate the effect of a change of temperature upon the rate of a chronometer, it is rare that an absolutely perfect compensation is attained, and it may therefore be assumed that the rates of all chronometers vary somewhat with the temperature. Where the voyage of a vessel is a long one and marked changes of climate are encountered, the accumulated error from the use of an incorrect rate may be very material, amounting to several minutes' difference of longitude. Careful navigators will therefore take every means to guard against such an error. By the employment of a *temperature curve* in connection with the chronometer rate the most satisfactory results are arrived at.

267. There should be furnished with each chronometer a statement showing its daily rate under various conditions of temperature; and this may be supplemented by the observations of the navigator during the time that the chronometer remains on board ship. With all available data a temperature curve should be constructed which will indicate graphically the performance of the instrument. It is most convenient to employ for this purpose a piece of "profile paper," on which parallel lines are ruled at equal intervals at right angles to each other. Let each horizontal line represent, say, a degree of temperature, numbered at the left edge, from the bottom up; draw a vertical line in red ink to represent the zero rate, and let all rates to the right be *plus*, or gaining, and those to the left *minus*, or losing; let the intervals between vertical lines represent intervals of rate (as one-tenth of a second) numbered at the top from the zero rate; then on this scale plot the rate corresponding to each temperature; when there are several observations covering one height of the thermometer, the mean may be used. Through all the plotted points draw a fair curve, and the intersection of this curve with each temperature line gives the mean rate at that temperature. The mean temperature given by the maximum and minimum thermometer shows the rate to be used on any day.

268. HACK OR COMPARING WATCH.—In order to avoid derangement, the chronometers should never be removed from the permanent box in which they are kept on shipboard. When it is desired to mark a certain instant of time, as for an astronomical observation or for obtaining the chronometer error by signal, the time is marked by a "hack" (an inferior chronometer used for this purpose only), or by a comparing watch. Careful comparisons are taken—preferably both before and afterwards—and the chronometer time at the required instant is thus deduced. The correction represented by the chronometer time *minus* the watch time (twelve hours being added to the former when necessary to make the subtraction possible) is referred to as C − W.

Suppose, for example, the chronometer and watch are compared and their indications are as follows:

Chro. t.,	5^h	27^m	30^s
W. T.,	−2	36	45.5
C − W,	2	50	44.5

If then a sight is taken when the watch shows $3^h\ 01^m\ 27^s.5$, we have:

W. T.,	3^h	01^m	$27^s.5$
C−W,	+2	50	44.5
Chro. t.,	5	52	12.0

It may occur that the values of C−W, as obtained from comparisons before and after marking the desired time, will vary; in that case the value to be used will be the mean of the two, if the time marked is about midway between comparisons, but if much nearer to one comparison than the other, allowance should be made accordingly.

Thus suppose, in the case previously given, a second comparison had been taken after the sight as follows:

Chro. t.,	6^h	12^m	45^s
W. T.,	−3	21	59.5
C−W,	2	50	45.5

The sight having been taken at about the middle of the interval, the C−W to be used would be the mean of the two, or $2^h\ 50^m\ 45^s.0$.

Let us assume, however, that the second comparison showed the following:

Chro. t.,	6^h	38^m	25^s
W. T.,	−3	47	39
C−W,	2	50	46

Then, the sight having been taken when only about one-third of the interval had elapsed between the first and second comparisons, it would be assumed that only one-third of the total change in the C−W had occurred up to the time of sight, and the value to be used would be $2^h\ 50^m\ 45^s.0$.

269. It is considered a good practice always to subtract watch time from chronometer time, whatever the relative values, and thus to employ C−W invariably as an additive correction. It is equally correct to take the other difference, W−C, and make it subtractive; it may sometimes occur that a few figures will thus be saved, but a chance for error arises from the possibility of inadvertently using the wrong sign, which is almost impossible by the other method. Thus, the following example may be taken:

Comparison	C,	10^h	57^m	38^s	W,	11^h	42^m	35^s
	W,	−11	42	35	C,	−10	57	38
	C−W,	11	15	03	W−C,	0	44	57
Sight	W,	11	50	21	W,	11	50	21
	C−W,	+11	15	03	W−C,	− 0	44	57
	C,	11	05	24	C,	11	05	24

CHAPTER IX.

TIME AND THE NAUTICAL ALMANAC.

270. The subjects of *Time* and the *Nautical Almanac* are two of the most important ones to be mastered in the study of Nautical Astronomy, as they enter into every operation for the astronomical determination of a ship's position. They will be treated in conjunction, as the two are interdependent.

METHODS OF RECKONING TIME.

271. The instant at which any point of the celestial sphere is on the meridian of an observer is termed the *transit*, *culmination*, or *meridian passage* of that point; when on that half of the meridian which contains the zenith, it is designated as *superior* or *upper* transit; when on the half containing the nadir, as *inferior* or *lower* transit.

272. Three different kinds of time are employed in astronomy—(*a*) *apparent* or *solar time*, (*b*) *mean time*, and (*c*) *sidereal time*. These depend upon the hour angle from the meridian of the points to which they respectively refer. The point of reference for apparent or solar time is the *Center of the Sun;* for mean time, an imaginary point called the *Mean Sun;* and for sidereal time, the *Vernal Equinox*, also called the *First Point of Aries*.

The unit of time is the *Day*, which is the period between two successive transits over the same branch of the meridian of the point of reference. The day is divided into 24 equal parts, called *Hours;* each hour is divided into 60 equal parts, called *Minutes*, and each minute into 60 equal parts, called *Seconds*.

273. Apparent or Solar Time.—The hour angle of the center of the sun affords a measure of *Apparent* or *Solar Time*. An *Apparent* or *Solar Day* is the interval of time between two successive transits over the same meridian of the center of the sun. It is *Apparent Noon* when the sun's hour circle coincides with the celestial meridian. This is the most natural and direct measure of time, and the unit of time adopted by the navigator at sea is the apparent solar day. Apparent noon is the time when the latitude can be most readily determined, and the ordinary method of determining the longitude by the sun involves a calculation to deduce the apparent time first.

Since, however, the intervals between the successive returns of the sun to the same meridian are not equal, apparent time can not be taken as a standard. The apparent day varies in length from two causes: first, the sun does not move in the equator, the great circle perpendicular to the axis of rotation of the earth, but in the ecliptic; and, secondly, the sun's motion in the ecliptic is not uniform. Sometimes the sun describes an arc of 57′ of the ecliptic, and sometimes an arc of 61′ in a day. At the points where the ecliptic and equinoctial intersect, the direction of the sun's apparent motion is inclined at an angle of 23° 27′ to the equator, while at the solstices it moves in a direction parallel to the equator.

274. Mean Time.—To avoid the irregularity of time caused by the want of uniformity in the sun's motion, a fictitious sun, called the *Mean Sun*, is supposed to move in the *equinoctial* with a uniform velocity that equals the *mean velocity of the true sun in the ecliptic*. This mean sun is regarded as being in coincidence with the true sun at the vernal equinox, or First Point of Aries.

Mean Time is the hour angle of the mean sun. A *Mean Day* is the interval between two successive transits of the mean sun over the meridian. *Mean Noon* is the instant when the mean sun's hour circle coincides with the meridian.

Mean time lapses uniformly; at certain times it agrees with apparent time, while sometimes it is behind, and at other times in advance of it. It is this time that is measured by the clocks in ordinary use, and to this the chronometers used by navigators are regulated.

275. The difference between apparent and mean time is called the *Equation of Time;* by this quantity, the conversion from one to the other of these times may be made. Its magnitude and the direction of its application may be found for any moment from the Nautical Almanac.

276. SIDEREAL TIME.—*Sidereal Time* is the hour angle of the First Point of Aries. This point, which is identical with the vernal equinox, is the origin of all coordinates of right ascension. Since the position of the point is fixed in the celestial sphere and does not, like the sun, moon, and planets, have actual or apparent motion therein, it shares in this respect the properties of the fixed stars. It may therefore be said that intervals of sidereal time are those which are measured by the stars.

A *Sidereal Day* is the interval between two successive transits of the First Point of Aries across the same meridian. *Sidereal Noon* is the instant at which the hour circle of the First Point of Aries coincides with the meridian. In order to interconvert sidereal and mean times an element is tabulated in the Nautical Almanac. This is the *Sidereal Time of Mean Noon,* which is also the *Right Ascension of the Mean Sun.*

277. CIVIL AND ASTRONOMICAL TIME.—The *Civil Day* commences at midnight and comprises the twenty-four hours until the following midnight. The hours are counted from 0 to 12, from midnight to noon; then, again, from 0 to 12, from noon to midnight. Thus the civil day is divided into two periods of twelve hours each, the first of which is marked a. m. (ante meridian), while the last is marked p. m. (post meridian).

The *Astronomical* or *Solar Day* commences at noon of the civil day of the same date. It comprises twenty-four hours, reckoned from 0 to 24, from noon of one day to noon of the next. Astronomical time (apparent or mean) is the hour angle of the sun (true or mean) measured to the westward throughout its entire circuit from the time of its upper transit on one day to the same instant of the next.

The civil day, therefore, begins twelve hours before the astronomical day, and a clear understanding of this fact is all that is required for interconverting these times. For example:

January 9, 2 a. m., civil time, is January 8, 14^h, astronomical time.

January 9, 2 p. m., civil time, is January 9, 2^h, astronomical time.

278. HOUR ANGLE.—The *hour angle* of a heavenly body is the angle at the pole of the celestial concave between the declination circle of the heavenly body and the celestial meridian. It is measured by the arc of the celestial equator between the declination circle and the celestial meridian.

In figure 35 let P be the pole of the celestial sphere, of which VMQ is the equator, PQ the celestial meridian, and PM, PS, PV the declination circles of the mean sun, a heavenly body, and the First Point of Aries, respectively.

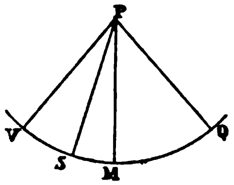

FIG. 35.

Then QPM, or its arc QM, is the hour angle of the mean sun, or the mean time; QPS, or QS, the hour angle of the heavenly body; QPV, or QV, the hour angle of the First Point of Aries, or the sidereal time; VPQ, or VQ, the right ascension of the meridian; VPS, or VS, the right ascension of the heavenly body; and VPM, or VM, the right ascension of the mean sun.

279. TIME AT DIFFERENT MERIDIANS.—The hour angle of the true sun at any meridian is called the *local apparent time;* that of the mean sun, the *local mean time;* that of the First Point of Aries, the *local sidereal time.* The hour angles of the same body and points from Greenwich are respectively the *Greenwich apparent, mean,* and *sidereal times.* The difference between the local time at any meridian and the Greenwich time is equal to the longitude of that place from Greenwich expressed in time; the conversion from time to arc may be effected by a simple mathematical calculation or by the use of Table 7.

In comparing corresponding times of different meridians the most easterly meridian may be distinguished as that at which the time is *greatest* or *latest.*

In figure 36 PM and PM′ represent the celestial meridians of two places, PS the declination circle through the sun, and PG the Greenwich meridian; let T_G = the Greenwich time = GPS;

T_M = the corresponding local time at all places on the meridian PM = MPS;
T_M' = the corresponding local time at all places on the meridian PM′ = M′PS;
Lo = west longitude of meridian PM = GPM; and
Lo′ = east longitude of meridian PM′ = GPM′.

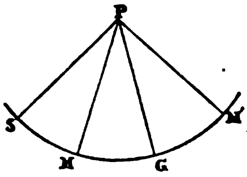

FIG. 36.

If west longitudes and hour angles be reckoned as positive, and east longitudes and hour angles as negative, we have:

$$\begin{aligned} Lo &= T_G - T_M;\ \text{and} \\ Lo' &= T_G - T_M';\ \text{therefore} \\ Lo - Lo' &= T_M' - T_M. \end{aligned}$$

Thus it may be seen that the difference of longitude between two places equals the difference of their local times. This relation may be shown to hold for any two meridians whatsoever.

Both local and Greenwich times in the above formulæ must be reckoned westward, always from their respective meridians and from 0^h to 24^h; in other words, it is the astronomical time which should be used in all astronomical computations.

The formula $Lo = T_G - T_M$ is true for any kind of time, solar or sidereal; or, in general terms, T_G and T_M are the hour angles of any point of the sphere at the two meridians whose difference of longitude is Lo. S may be the sun (true or mean) or the vernal equinox.

280. FINDING THE GREENWICH TIME.—Since nearly every computation made by the navigator requires a knowledge of the Greenwich date and time as a preliminary to the use of the Nautical Almanac, the first operation necessary is to deduce from the local time the corresponding Greenwich date, either exact or approximate, and thence the Greenwich time expressed astronomically.

The formula is:

$$T_G = T_M + Lo,$$

remembering that west longitudes are positive, east longitudes are negative. Hence the following rule for converting local to Greenwich time:

Having expressed the local time astronomically, *add* the longitude if *west*, *subtract* it if *east;* the result is the corresponding Greenwich time.

EXAMPLE: In longitude 81° 15′ W. the local time is, April, $15^d\ 10^h\ 17^m\ 30^s$ a. m. Required the Greenwich time.

Local Ast. time, April,	14^d	22^h	17^m	30^s
Longitude,	+	5	25	00
Greenwich time,	15	3	42	30

EXAMPLE: In longitude 81° 15′ E. the local time is, August, $5^d\ 2^h\ 10^m\ 30^s$ p. m. Required the Greenwich time.

Local Ast. time, August,	5^d	2^h	10^m	30^s
Longitude,	—	5	25	00
Greenwich time,	4	20	45	30

EXAMPLE: In longitude 17° 28′ W. the local time is, May, $1^d\ 3^h\ 10^m$ p. m. Required the Greenwich time.

Local Ast. time, May,	1^d	3^h	10^m	00^s
Longitude,	+	1	09	52
Greenwich time,	1	4	19	52

EXAMPLE: In longitude 125° 30′ E. the local time is, May, $1^d\ 8^h\ 10^m\ 30^s$ a. m. Required the Greenwich time.

Local Ast. time, April,	30^d	20^h	10^m	30^s
Longitude,	–	8	22	00
Greenwich time,	30	11	48	30

281. From the preceding article we have:

$$T_G = T_M + Lo; \text{ hence,}$$
$$T_M = T_G - Lo;$$

thus it will be seen that, to find the local time corresponding to any Greenwich time, the above process is simply reversed.

Since all observations at sea are referred to chronometers regulated to Greenwich mean time, and as these instruments are usually marked on the dial from 0^h to 12^h, it becomes necessary to distinguish whether it is a. m. or p. m. at Greenwich. Therefore an approximate knowledge of the longitude and local time is necessary to determine the Greenwich date.

EXAMPLE: In longitude $5^h\ 00^m\ 00^s$ W., about $3^h\ 30^m$ p. m. April 15th, the Greenwich chronometer read $8^h\ 25^m$, and was fast of Gr. time $3^m\ 15^s$. Required the local astronomical time.

Approx. local time,	$15^d\ 3^h\ 30^m$	Gr. chro.,	$8^h\ 25^m\ 00^s$	Gr. Ast. time 15^d,	$8^h\ 21^m\ 45^s$
Longitude,	$+\ 5\ 00$	Corr.,	$-\ 3\ 15$	Longitude,	$-5\ 00\ 00$
Approx. Gr. time,	15 8 30	Gr. Ast. time 15^d,	8 21 45	Local Ast. time 15^d,	3 21 45

EXAMPLE: In longitude $5^h\ 00^m\ 00^s$ E., about 8 a. m. May 3d, the Gr. chro. read $3^h\ 15^m\ 20^s$, and was fast of Gr. time $3^m\ 15^s$. Required the local astronomical time.

Approx. local time, May,	$2^d\ 20^h$	Gr. chro.,	$3^h\ 15^m\ 20^s$	Gr. Ast. time 2^d,	$15^h\ 12^m\ 05^s$
Longitude,	$-\ 5$	Corr.,	$-\ 3\ 15$	Longitude,	$+\ 5\ 00\ 00$
Approx. Gr. time,	2 15	Gr. Ast. time 2^d,	15 12 05	Local Ast. time 2^d,	20 12 05

THE NAUTICAL ALMANAC.[a]

282. *The American Ephermeris and Nautical Almanac* is divided into three parts as follows: Part I, Ephemeris for the meridian of Greenwich, gives the ephemerides of the sun and moon, the geocentric and heliocentric positions of the major planets, the sun's coordinates, and other fundamental astronomical data for equidistant intervals of Greenwich mean time; Part II, Ephemeris for the meridian of Washington gives the ephemerides of the fixed stars, sun, moon, and major planets for transit over the meridian of Washington, and Part III, Phenomena, contains predictions of phenomena to be observed with data for their computation. Tables are also appended for the interconversion of mean and sidereal time and for finding the latitude and azimuth by an altitude of Polaris.

The American Nautical Almanac is a smaller book made up of extracts from the "Ephemeris and Almanac" just described, and is designed especially for the use of navigators, being adapted to the meridian of Greenwich. It contains the position of the sun and moon, together with the ephemerides of the planets Venus, Mars, Jupiter, and Saturn, and the apparent places of 55 stars for the first of each month and the Greenwich mean time of transit at Greenwich for each of these stars, also the mean places of 110 additional stars; solar and lunar eclipses are described, and the tables for the interconversion of mean and sidereal time and for finding the latitude by Polaris are included.

The elements dependent upon the sun and moon are placed in the first part of the book, arranged according to hours, days, and months of the year. The right ascension of the mean sun for the entire year is given at one opening, also, the mean time of sidereal noon at Greenwich; the declination of the sun, equation of time, the right ascension and declination of the moon and the moon's horizontal parallax and semidiameter are given for every even hour throughout the year. They must be taken from the Almanac for some definite instant of Greenwich mean time. In computations from observations that depend upon the time of the sun's meridian passage, at which instant the local apparent time is 0^h, and the Greenwich apparent time is equal to the longitude, if west, or to 24^h minus the longitude, if east, it becomes necessary to correct the equation of time for longitude, before it is applied to the Greenwich apparent time to obtain a Greenwich mean time for use in taking out other desired data. This Greenwich mean time is sufficiently correct for all practical purposes as the equation of time never changes more than $1^s.3$ in an hour.

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[a] See extracts from Ephemeris and Nautical Almanac for 1916, Appendix I.

283. REDUCTION OF ELEMENTS.—The reduction of elements in the Nautical Almanac is usually accomplished by *Interpolation*, but in certain cases where extreme precision is necessary the method of *Second Differences* must be used.

The Ephemeris, being computed for the Greenwich meridian, contains the right ascensions, declinations, equations of time, and other elements for given equidistant intervals of Greenwich time. Hence, before the value of any of these quantities can be found for a given local time it is necessary to determine the corresponding Greenwich time. Should that time be one for which the Nautical Almanac gives the value of the required element, nothing more is necessary than to employ that value. But if the time falls between the Almanac times, the required quantity must be found by interpolation.

The Almanac contains the rate of change or difference of each of the principal quantities for some unit of time, and, unless great precision is required, the first differences only need be regarded. In order to use the difference columns to advantage, the Greenwich date should be expressed in the unit of time for which the difference is given. Thus, for using the hourly differences, the Greenwich time should be expressed in hours and decimal parts of an hour; when using the differences for one minute, the time should be in minutes and decimal parts of a minute. Instead of using decimal parts, some may prefer the use of aliquot parts.

Since the quantities in the Almanac are approximate numbers, given to a certain decimal, any interpolation of a lower order than that decimal is unnecessary work. Moreover, since, in computations at sea, the Greenwich time is more or less inexact, too great refinement need not be sought in reducing the Almanac elements.

Simple interpolation assumes that the differences of the quantities are proportional to the differences of the times; in other words, that the differences given in the Almanac are constant; this is seldom the case, but the error arising from the assumption will be smaller the less the interval between the times in the Almanac. Hence those quantities which vary most irregularly are given for the smallest units of time; as the variations are more regular, the units for which the differences are given increase.

In taking from the Almanac the elements relating to the fixed stars the data may be found either in the table which gives the "mean place" of each star for the year or in that which gives the "apparent place" occupied by each one on the first day of each month. As the annual variation of position of the fixed stars is small, the results will not vary greatly whichever table may be used. Yet, as it is proper to seek always the greatest attainable accuracy, the use of the table showing the exact positions is recommended.

284. To find from the Nautical Almanac a required element for any given time and place, it is first necessary to express the time astronomically and to convert it to Greenwich time and date. Then take from the Almanac, for the nearest given *preceding* instant, the required quantity, together with its corresponding "hourly" or "two-hourly difference," noting the name or sign in each case. Multiply the "hourly difference" by the number of hours and fraction of an hour, or use Table IV, N. A. (proportional parts), corresponding to the interval between the time for which the quantity is given in the Almanac and the time for which required; apply the correction thus obtained, having regard to its sign.

A modification of this rule may be adopted if the time for which the quantity is desired falls considerably nearer a *subsequent* time given in the Almanac than it does to one preceding; in this case the interpolation may be made backward, the sign of application of the correction being reversed.

Example: At a place in longitude 81° 15′ W., April 17, 1916, find the sun's declination and the equation of time at apparent noon.

Long. = 81° 15′ W. G. A. T. = $17^d\ 5^h\ 25^m = 17^d + 5^h.42$.

G. A. T., 17^d,	$5^h\ 25^m\ 00^s$	Eq. t., $17^d\ 4^h$,	$0^m\ 26^s.1$	H. D.,	$+0^s.6$
Eq. t.,	− 27	Corr.,	+ .8	Int.,	$1^h.42$
G. M. T., 17^d,	5 24 33	Eq. t., $17^d\ 5^h\ 25^m$,	0 26 .9	Corr.,	$+0^s.852$
	= $5^h.4$		(*Add* to *mean* time.)		

Dec., $17^d\ 4^h$,	10° 31′.0 N.	H. D.,	+0′.9
Corr.,	+ 1 .3	G. M. T.,	$1^h.4$
Dec., $17^d\ 5^h\ 25^m$,	10 32 .3 N.	Corr.,	+1′.26

Example: At a place in longitude 81° 15′ E., April 17, 1916, find the sun's declination and the equation of time at apparent noon.

Long. = 81° 15′ E. G. A. T. = $16^d\ 18^h\ 35^m = 17^d - 5^h.42$.

G. A. T., 16^d,	$18^h\ 35^m\ 00^s$	Eq. t., $16^d\ 18^h$,	$0^m\ 20^s.2$	H. D.,	$0^s.6$
Eq. t.,	− 0 20 .5	Corr.,	+ 0 .3	Int.,	$0^h.58$
G. M. T., 16^d,	18 34 39 .5	Eq. t., $16^d\ 18^h\ 35^m$,	0 20 .5	Corr.	$+0^s.348$
	= 18 .58		(*Add* to *mean* time.)		

Dec., $16^d\ 18^h$,	10° 22′.2 N.	H. D.,	+0′.9
Corr.,	+ .5	G. M. T.,	$0^h.58$
Dec., $16^d\ 18^h\ 35^m$,	10° 22′.7 N.	Corr.,	+0′.522

Example: April 15, 1916, at $11^h\ 55^m\ 30^s$ a. m., local mean time, in Long. 81° 15′ W., required the declination and semidiameter of the sun, the equation of time, and the right ascension, declination, horizontal parallax, and semidiameter of the moon and Jupiter.

Local mean time,	$14^d\ 23^h\ 55^m\ 30^s$
Longitude,	+ 5 25 00
Greenwich mean time,	15 5 20 30 $15^d\ 5^h\ 20^m.5$ $15^d\ 5^h.34$

For the Sun.

Dec., $15^d\ 4^h$,	9° 48′.5 N.	S. D.,	15′ 58″	Eq. t., $15^d\ 4^h$,	$0^m\ 02^s.8$
Corr.,	+ 1 .2	(Same as at G. A. Noon.)		Corr.,	− 0 .8
Dec.,	9 49 .7 N.			Eq. t.,	0 02
H. D.,	+ 0′.9			H. D.,	− $0^s.6$
G. M. T.,	$1^h.34$			G. M. T.,	$1^h.34$
Corr.,	+ 1′.20			Corr.,	− $0^s.804$
					(*Subtract* from *mean* time.)

For the Moon.

R. A. $15^d\ 4^h$,	$11^h\ 28^m\ 14^s$	Hor. Par., $15^d\ 5^h.34$,	57′.1	Dec., $15^h\ 4^h$,	0° 39′.8 S.
Corr.,	+ 2 38	S. D., $15^d\ 5^h.34$,	15′.6	Corr.,	− 19 .8
R. A.,	11 30 52			Dec.,	0 59 .6 S.
H. D.,	+ 118^s			H. D.,	− 14′.7
G. M. T.,	$1^h.34$			G. M. T.,	$1^h.34$
Corr.,	+ 158^s $2^m\ 38^s$			Corr.,	− 19′.8

(By proportional parts Table IV, N. A.)

R. A., $15^d\ 6^h$,	$11^h\ 32^m\ 10^s$
Corr., $39^m.5$,	− 1 18
R. A.,	11 30 52

(By proportional parts Table IV, N. A.)

Dec., $15^d\ 6^h$,	(−)1° 09′.3 S.
Corr., $39^m.5$,	+ 19 .7
Dec.,	0 59 .6 S.

For Jupiter.

R. A., $15^d\ 0^h$.,	$0^h\ 56^m\ 28^s$	Hor. Par., 15^d,	0′.02	Dec., $15^d\ 0^h$,	+ 4° 51′.5 N.
Corr.,	+ 12	S. D., 15^d,	0′.26	Corr.,	+ 1 .2
R. A.,	0 56 40			Dec.,	4 52 .7 N.
H. D.,	+ $2^s.25$			H. D.,	+ 0′.23
G. M. T.,	$5^h.34$			G. M. T.,	$5^h.34$
Corr.,	+ 12^s			Corr.,	+ 1′.22

(Prop. parts Table IV, N. A. (See p. 253*b*.))

R. A., $15^d\ 0^h$,	$0^h\ 56^m\ 28^s$
Corr., $5^h\ 20^m$,	+ 12
R. A.,	0 56 40

(Prop. parts Table IV, N. A.)

Dec., $15^d\ 0^h$,	+ 4° 51′.5 N.
Corr., $5^h\ 20^m$,	+ 1 .2
Dec.,	4 52 .7 N.

285. Should greater precision be required than that attainable by simple interpolation, resort must be had to the reduction for second differences, for which use the Ephemeris and Nautical Almanac.

The differences between successive values of the quantities given in the Ephemeris and Nautical Almanac are called the *first differences;* the differences between successive first differences are called the *second differences.* Simple interpolation, which satisfies the necessities of sea computations, assumes the first differences to be constant; but if the variation of the first differences be regarded, a further interpolation is required for the second difference.

The difference for a unit of time in the American Ephemeris and Nautical Almanac abreast any element expresses the rate at which the element is changing at that precise instant of Greenwich time. Now, regarding the second difference as constant, the first difference varies uniformly with the Greenwich time; therefore its value may be found for any intermediate time by simple interpolation.

Hence the following rule for second differences: Employ the interpolated value of the first difference which corresponds to the *middle* of the interval for which the correction is to be computed.

EXAMPLE: For the Greenwich date 1916, April, $10^d\ 18^h\ 25^m\ 30^s$, find the moon's declination.

Dec., 18^h,	(+)21° 09′ 41″.8 N.	First diff.,	−	8″.522	Second diff.,	−0″.096
Corr.,	− 3 37 .8	Corr.,	−	0 .020	Interval,	$+0^h$.213
Dec.,	21 06 04 N.	M. D.,	−	8 .542	Corr.,	−0″.020
		No. min.,	+	25^m.5		
		Corr.,	−	217″.8 3′ 37″.8		

The difference for one minute being −8″.522 at 18^h, and −8″.618 at 19^h, the difference for one minute undergoes a change of −0″.096 during one hour. The time for which it is desired to obtain the difference is at the middle instant between $18^h\ 0^m$ and $18^h\ 25^m$.5—that is, at $18^h\ 12^m$.75, or its equivalent, 18^h.213. With a change of −0″.096 in one hour, the change in 0^h.213 is readily obtainable; correcting the minute's difference at 18^h.0 accordingly, the process of correcting the declination becomes the same as in simple interpolation.

CONVERSION OF TIMES.

286. *Conversion of Time* is the process by which any instant of time that is defined according to one system of reckoning may be defined according to some other system; and also by which any interval of time expressed in units of one system may be converted into units of another.

287. SIDEREAL AND MEAN TIME.—Mean time is the hour angle of the Mean Sun; sidereal time is the hour angle of the First Point of Aries. Since the Right Ascension of the Mean Sun is the angular distance between the hour circles of the First Point of Aries and of the Mean Sun, mean time may be converted into sidereal time by adding to it the Right Ascension of the Mean Sun; and similarly, sidereal time may be converted into mean time by subtracting from it the Right Ascension of the Mean Sun.

This is explained in figure 37, which represents a projection of the celestial sphere upon the equator. If P be the pole; QPQ′, the meridian; V, the First Point of Aries; M, the position of the mean sun (west of the meridian); then QPV, or the arc QV, is the sidereal time; QPM, or the arc QM, is the mean time; and VPM, or the arc VM, is the Right Ascension of the Mean Sun. From this it will appear that:

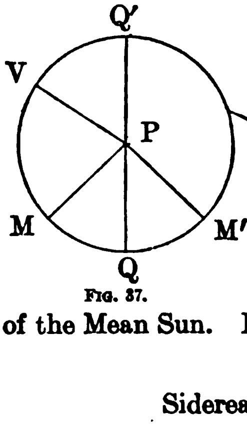

FIG. 37.

$$QV = QM + VM, \text{ or}$$
$$\text{Sidereal time} = \text{Mean time} + \text{Right Ascension of Mean Sun.}$$

If the mean sun be on the opposite side of the meridian, at M′, then the mean time equals $24^h - M'Q$. In this case:

$$QV = VM' - M'Q, \text{ or}$$
$$\text{Sidereal time} = \text{Right Ascension of Mean Sun} - (24^h - \text{Mean time}),$$
$$= \text{Right Ascension of Mean Sun} + \text{Mean time} - 24^h.$$

Right ascension being measured to the east and hour angle to the west, the sidereal time will therefore always equal the sum of these two; but 24^h must be subtracted when the sum exceeds that amount.

From the preceding equations, we also have:

$$QM = QV - VM; \text{ and}$$
$$M'Q = VM' - QV, \text{ or}$$
$$(24^h - M'Q) = (24^h + QV) - VM'.$$

From this it may be seen that the mean time equals the sidereal time *minus* the Right Ascension of the Mean Sun, but the former must be increased by 24^h when necessary to make the subtraction possible.

288. Apparent and Mean Times.—Apparent time is the angle between the meridian and the hour circle which contains the center of the sun; mean time is the angle between the meridian and the hour circle which contains the mean sun. Since the equation of time represents the angle between the hour circles of the mean and apparent suns, it is clear that the conversion of mean time to apparent time may be accomplished by the application of the equation of time, with its proper sign, to the mean time; and the reverse operation by the application of the same quantity, in an opposite direction, to the apparent time.

The resemblance of these operations to the interconversion of mean and sidereal times may be observed if, in figure 37, we assume that PV is the hour circle of the true sun, PM remaining that of the mean sun; then the arc QM will be the mean time; QV, the apparent time; and VM, the equation of time; whence we have as before:

$$QV = QM + VM, \text{ or}$$
$$\text{Apparent time} = \text{Mean time} + \text{Equation of time};$$

the equation of time will be positive or negative according to the relative position of the two suns.

289. Sidereal and Mean Time Intervals.—The sidereal year consists of 366.25636 sidereal days or of 365.25636 mean solar days. If, therefore, M be any interval of mean time, and S the corresponding interval of sidereal time, the relations between the two may be expressed as follows:

$$\frac{S}{M} = \frac{366.25636}{365.25636} = 1.0027379;$$

$$\frac{M}{S} = \frac{365.25636}{366.25636} = 0.9972696.$$

$$\text{Therefore, } S = 1.0027379\ M = M + .0027379\ M;$$
$$M = 0.9972696\ S = S - .0027304\ S.$$

If $M = 24^h$, $S = 24^h + 3^m\ 56^s.6$; or, in a mean solar day, sidereal time gains on mean time $3^m\ 56^s.6$, the gain each hour being $9^s.8565$.

If $S = 24^h$, $M = 24^h - 3^m\ 55^s.9$; or, in a sidereal day, mean time loses on sidereal time $3^m\ 55^s.9$, the loss each hour being $9^s.8296$.

If M and S be expressed in hours and fractional parts thereof,

$$S = M + 9^s.8565\ M;$$
$$M = S - 9^s.8296\ S.$$

Tables for the conversion of the intervals of mean into those of sidereal time and the reverse are based upon these relations. Tables 8 and 9 of this work give the values for making these conversions, and similar tables are to be found in the Nautical Almanac.

290. To Convert Mean Solar into Sidereal Time.—Apply to the local mean time the longitude, adding if west and subtracting if east, and thus obtain the Greenwich mean time. Take from the Nautical Almanac the Right Ascension of the Mean Sun at Greenwich mean noon, and correct it for the Greenwich mean time by Table III, N. A., or Table 9 (Bowditch), or by the hourly difference of $9^s.857$. Add to the local mean time this corrected right ascension, rejecting 24^h if the sum is greater than that amount. The result will be the local sidereal time.

Example: April 22, 1916, in Long. 81° 15′ W., the local mean time is $2^h\ 00^m\ 00^s$ p. m. Required the corresponding local sidereal time.

L. M. T.,	22^d	2^h	00^m	00^s	R. A. M. S., $22^d\ 0^h$,	2^h	00^m	$50^s.4$	L. M. T.,	2^h	00^m	00^s
Long.,	+	5	25	00	Red. for $7^h\ 25^m$ (Tab. 9), +		1	13 .1	R. A. M. S., +	2	02	03 .5
G. M. T.,	22	7	25	00	R. A. M. S., $7^h\ 25^m$,	2	02	03 .5	L. S. T.,	4	02	03 .5

Example: April 22, 1916, in Long. 75° E., the local mean time is $4^h\ 00^m\ 00^s$ a. m. Required the local sidereal time.

L. M. T.,	21^d	16^h	00^m	00^s	R. A. M. S., $21^d\ 0^h$,	1^h	56^m	$53^s.8$	L. M. T.,	21^d	16^h	00^m	00^s
Long.,	−	5	00	00	Red. for 11^h (Tab. 9), +		1	48 .4	R. A. M. S., +		1	58	42 .2
G. M. T.,	21	11	00	00	R. A. M. S., 11^h,	1	58	42 .2	L. S. T.,	21	17	58	42 .2

In these examples the reduction of the R. A. M. S. has formed a separate operation in order to make clear the process. It would be as accurate to add together directly L. M. T., R. A. M. S., and Red., and the work would thus be rendered more brief.

291. To Convert Sidereal into Mean Solar Time.—Take from the Nautical Almanac the Right Ascension of the Mean Sun for Greenwich mean noon of the given astronomical day, and apply to it the reduction for longitude, either by Table 9 or by the hourly difference of $9^s.857$, and the result will be the Right Ascension of the Mean Sun at local mean noon, which is equivalent to the local sidereal time at that instant. Subtract this from the given local sidereal time (adding 24^h to the latter if necessary), and the result will be the interval from local mean noon, expressed in units of sidereal time. Convert this sidereal time interval into a mean time interval by subtracting the reduction as given by Table II, N. A., or Table 8, or by the hourly difference of $9^s.830$; the result will be the local mean time.

Example: April 22, 1916, a. m., in Long. 75° E., the local sidereal time is $17^h\ 58^m\ 42^s.2$. What is the local mean time?

Astronomical day, April 21.

L. S. T.,	17^h	58^m	$42^s.2$	R. A. M. S., Gr. $21^d\ 0^h$,	1^h	56^m	$53^s.8$
R. A. M. S.,	− 1	56	04 .5	Red. for -5^h long. (Tab. 9), −			49 .3
Sid. interval from L. M. noon,	16	02	37 .7	R. A. M. S., local 0^h,	1	56	04 .5
Red. for sid. interval (Tab. 8),		2	37 .7				
L. M. T., 21^d,	16	00	00 .0				

Example: April 22, 1916, p. m., at a place in Long. 81° 15′ W., the sidereal time is $4^h\ 02^m\ 03^s.5$. What is the corresponding mean time?

Astronomical day, April 22.

L. S. T.,	4^h	02^m	$03^s.5$	R. A. M. S., Gr. $22^d\ 0^h$,	2^h	00^m	$50^s.4$
R. A. M. S.,	− 2	01	43 .8	Red. for $+5^h\ 25^m$ long. (Tab. 9), +		0	53 .4
Sid. interval from L. M. Noon,	2	00	19 .7	R. A. M. S., local 0^h,	2	01	43 .8
Red. for sid. interval (Tab. 8), −		0	19 .7				
L. M. T., 22^d,	2	00	00 .0				

292. To Convert Mean into Apparent Time and the Reverse.—Find the Greenwich time corresponding to the given local time. If apparent time is given, find the Greenwich apparent time and take the equation of time from the Almanac. If mean time, find the Greenwich mean time, correct the equation of time for the required instant and apply it with its proper sign to the given time.

Example: April 21, 1916, in Long. 81° 15′ W., find the local apparent time corresponding to a local mean time of $3^h\ 05^m\ 00^s$ p. m.

L. M. T.,	$21^d\ 3^h\ 05^m\ 00^s$	L. M. T.,	$21^d\ 3^h\ 05^m\ 00^s$	Eq. t., 8^h,	$1^m\ 21^s.3$
Long.,	+ 5 25 00	Eq. t.,	+ 1 21 .5	Corr.,	+ 0. 2
G. M. T.,	21 8 30 00	L. A. T.,	21 3 06 21 .5	Eq. t.,	1 21. 5
				H. D.,	+ $0^s.5$
				G. M. T.,	+ $0^h.5$
				Corr.,	+ $0^s.25$
				(*Add* to *mean* time.)	

Example: April 3, 1916, in Long. 81° 15′ E., the local apparent time is $8^h\ 45^m\ 00^s$ a. m. Required the mean time.

L. A. T.,	$2^d\ 20^h\ 45^m\ 00^s$	L. A. T.,	$2^d\ 20^h\ 45^m\ 00^s$	Eq. t., 14^h,	$3^m\ 30^s.6$
Long.,	− 5 25 00	Eq. t.,	+ 3 29 .7	Corr.,	− 0 .9
G. A. T.,	2 15 20 00	L. M. T.,	2 20 48 29 .7	Eq. t.,	3 29 .7
				H. D.,	− $0^s.7$
				Int.,	+ $1^h.33$
				Corr.,	− $0^s.93$
				(*Add* to *apparent* time.)	

293. To Find the Hour Angle of a Body from the Time, and the Reverse.—In figure 37, if M and M′ represent the positions of celestial bodies instead of those of the mean sun as before assumed, then the hour angles of the bodies will be Q M and 24^h − M′ Q, respectively, and their right ascensions will be V M and V M′.

As before, we have:

$$
\begin{aligned}
QV &= QM + VM,\\
&= VM' - M'Q;\\
QM &= QV - VM;\\
M'Q &= VM' - VQ, \text{ or}\\
(24^h - M'Q) &= (24^h + QV) - VM'.
\end{aligned}
$$

Substituting, therefore, *hour angle of the body* for *mean time*, and *right ascension of the body* for *Right Ascension of the Mean Sun*, the rules previously given for the conversion of mean and sidereal times will be applicable for the conversion of hour angle and sidereal time. Thus, the sidereal time is equal to the sum of the right ascension of the body and its hour angle, subtracting 24^h when the sum exceeds that amount; and the hour angle equals the sidereal time *minus* the right ascension of the body, 24^h being added to the former when necessary to render the subtraction possible.

Example: In Long. 81° 15′ W., on April 25, 1916, at $12^h\ 10^m\ 30^s$ (astronomical) mean time, find the hour angle of Sirius.

L. M. T.,	$12^h\ 10^m\ 30^s$	L. M. T.,	$12^h\ 10^m\ 30^s.0$
Long.,	+ 5 25 00	R. A. M. S., 0^h,	+ 2 12 40 .0
G. M. T.,	17 35 30	Red. (Tab. 9),	+ 2 53 .4
		L. S. T.,	14 26 03 .4
		R. A. Sirius,	− 6 41 27 .6
		H. A. Sirius,	7 44 35 .8

Example: May 9, 1916, Arcturus being $2^h\ 27^m\ 42^s.52$ east of the meridian, find the local sidereal time.

	$24^h\ 00^m\ 00^s$	H. A.,	$21^h\ 32^m\ 17^s.48$
H. A.,	2 27 42.52 E.	R. A.,	+14 11 52 .9
H. A.,	21 32 17.48 W.	L. S. T.,	11 44 10 .38

Or thus:

H. A.,	− $2^h\ 27^m\ 42^s.52$
R. A.,	+14 11 52 .9
L. S. T.,	11 44 10 .38

294. Many navigators find the conversion of time much simplified and more easily grasped by roughly plotting the elements as they are presented in any given case, in a figure drawn on the plane of the celestial equator. Noting the known elements and the elements required to be found, a study of the figure shows very quickly how to combine the known elements to get the unknown elements.

Following this method, the examples of articles 290, 291, and 293 are here solved as an alternative to the preceding treatment, since it is found that, for many who have learned this method of procedure in the beginning, every difficulty in reckoning or converting time has been obviated. Although the explanation may appear somewhat long, the actual plotting and solution of any given case take only a few seconds when the method is understood. In the figures, P represents the elevated pole; Q, the intersection of the local meridian with the equator; G, the intersection of the meridian of Greenwich with the equator; V, the First Point of Aries (Vernal Equinox); S_m, the mean sun; S_a, the apparent sun; and ✱, a star or planet.

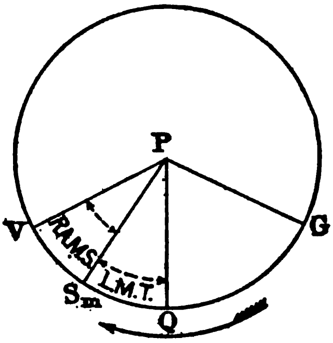

FIG. 38.

FIRST EXAMPLE OF ARTICLE 290. (SEE FIGURE 38.)

Draw a circle to represent the plane of the celestial equator, P being the projection of the pole, and PQ the projection of the local meridian. From P draw the projection of the hour circle of the Greenwich meridian which (since the longitude is west) is laid off to the right or eastward of the local meridian so that the arc QG equals the longitude. The arrow indicates westerly direction and shows the direction in which the hour circles of the heavenly bodies move around the circle on the earth's axis. The L. M. T. being p. m., we lay off the hour circle of the mean sun to the westward of the local meridian so that the arc QS_m equals the L. M. T. We see at once from the figure that the G. M. T. (the position of the hour circle of the mean sun, S_m, with reference to the Greenwich meridian) is the arc GQS_m, which equals Long. + L. M. T. Having thus found the G. M. T., we can find the right ascension of the mean sun at that instant from the Nautical Almanac (picked out for the day and corrected for the G. M. T.) which, in this case, is $2^h\ 02^m\ 03^s.5$. The correction is (+) or additive to the angle which represents the R. A. M. S. for Greenwich Mean Noon because this angle has been increased by this amount owing to the gain of the Vernal Equinox over the mean sun for the angle through which the mean sun has traveled from the Greenwich meridian. The mean sun is to the eastward of the Vernal Equinox by the amount of its right ascension. We therefore lay off PV, the hour circle of the Vernal Equinox, so that the arc VS_m equals the R. A. M. S. Since the L. S. T. equals the H. A. of the Vernal Equinox, we see at once from the figure that the L. S. T. equals R. A. M. S. + L. M. T.

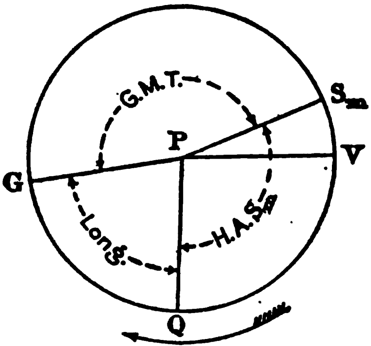

FIG. 39.

SECOND EXAMPLE OF ARTICLE 290. (SEE FIGURE 39.)

Draw a circle to represent the plane of the celestial equator. Project the pole P and the local meridian PQ. Draw the arrow pointed west to show the direction in which the hour circles move. Since the longitude is east, we know that the Greenwich meridian is to the westward of the local meridian, and we draw PG, the Greenwich meridian, so that the arc QG equals the longitude, equals 5 hours. Since the L. M. T. is $4^h\ 00^m\ 00^s$ a. m., we know that it will be $12^h - 4^h$ equals 8^h before the sun crosses the local meridian; hence we lay off the arc QS_m to equal the sun's H. A., which equals 8^h, and draw PS_m, the hour circle of the mean sun. We see from the figure that the hour angle of the mean sun from Greenwich (G. M. T.) is equal to $24^h -$ (Long. + H. A. S_m), and that, since the mean sun must travel around the arc to the west from S_m to G to make the time 0 hours on April 22 at

Greenwich, the date must be April 21, and the G. M. T. is 11 hours. For this Greenwich date, we get, from the Nautical Almanac (corrected for G. M. T.) the R. A. M. S. equal to $1^h\ 58^m\ 42^s.2$, which is the amount the hour circle of the mean sun is to the eastward of the hour circle of the Vernal Equinox. The correction is + or additive for the reason given in the preceding example. Lay off the arc S_mV equal to the R. A. M. S. and draw the hour circle of the Vernal Equinox PV. An inspection of the figure shows us that the L. S. T. is the arc QGV which is equal to the Long. + G. M. T. + R. A. M. S., or to the L. M. T. + the R. A. M. S. We also see that L. M. T. equals the Long. + G. M. T.

FIRST EXAMPLE OF ARTICLE 291. (SEE FIGURE 40.)

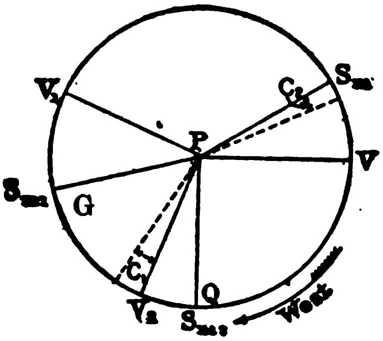

FIG. 40.

Draw the figure as shown, laying off the longitude equal to 5 hours east, to the westward from Q, thus finding the Greenwich meridian G. The given L.S.T. is 18 hours, so lay off QV (equal to 18 hours) to the westward from Q, given the position of V, the Vernal Equinox or First Point of Aries, for the instant desired. The problem is to plot the position of the mean sun at this instant, and thence find its local hour angle, or the L. M. T. We plot this position of the mean sun by laying off its right ascension to the eastward from V. The R. A. M. S. is found from the Almanac for a particular instant which is at Greenwich mean noon of the astronomical date, April 21, and which we find is $1^h\ 56^m\ 53^s.8$. Plot in S_{m1}, over the Greenwich meridian and lay off this angle GV_1, to the westward from G, giving us the position of V at Greenwich mean noon. As we are reckoning hour angles from the local meridian, we must move the sun back to Q and find the position V_2 at the instant of local mean noon. To find V_2 we must find the angle QV_2 which will be less than GV_1, as the First Point of Aries always advances faster toward the west than the mean sun. The amount of this gain of the Vernal Equinox over the mean sun depends on the angular distance through which the mean sun travels, i. e., in this case from Q to G equals the longitude, equals 5 hours. From Table 9 we find the gain, which is represented by the sector C_1 in the figure, to be $49^s.3$ for the 5 hours, so that QV_2 equals $GV_1 - 49^s.3$, equals $1^h\ 56^m\ 53^s.8 - 49^s.3$, equals $1^h\ 56^m\ 04^s.5$. Now we have the position V_2 for the instant of time when the mean sun was at Q, that is for the position S_{m2} or local mean noon. For the instant of time desired the Vernal Equinox is not at V_2 but at V and at this instant we must find S_{m}. The Vernal Equinox has moved from V_2 to the westward to V or through the arc V_2 V which equals $QV - QV_2$, equals $17^h\ 58^m\ 42^s.2 - 1^h\ 56^m\ 04^s.5$, equals $16^h\ 02^m\ 37^s.7$, which is called a sidereal interval. During this travel of the Vernal Equinox the mean sun will lose a certain angular amount on the Vernal Equinox, depending on the travel of the latter, which travel is $16^h\ 02^m\ 37^s.7$. From Table 8, we find for this travel that the loss will be $2^m\ 37^s.7$, which is represented by the sector C_2 in the figure, so that the angle QS_m is $V_2\ V - 2^m\ 37^s.7$, equals $16^h\ 02^m\ 37^s.7 - 2^m\ 37^s.7$, equals $16^h\ 00^m\ 00^s$, which, from the figure, equals the desired L. M. T.

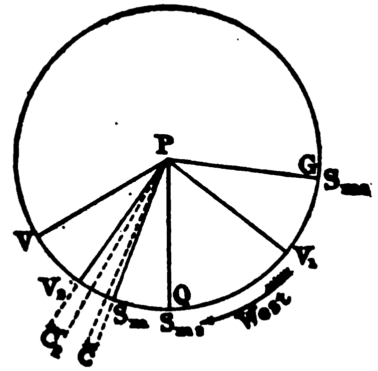

FIG. 41.

SECOND EXAMPLE OF ARTICLE 291. (SEE FIGURE 41.)

Draw the figure as shown, laying off the longitude equal to 5^h west, to the eastward from Q, thus finding the Greenwich meridian G. The problem is similar to the above problem except that in moving the mean sun from G to Q we see that the angle $S_{m1}\ V_1$ is increased to find $S_{m2}\ V_2$, as the Vernal Equinox has gained a certain amount on the mean sun during the travel of the sun to the westward from G to Q. For the travel of V_2 to V, the mean sun will travel from S_{m2} to S_m, losing a certain amount on the Vernal Equinox for the travel of V_2 V of the latter, and we find QS_m equals the L. M. T.

FIRST EXAMPLE OF ARTICLE 293. (SEE FIGURE 42.)

Draw the figure as explained above, using longitude given equals 5 hours west, and L. M. T. given, 12 hours (+). Then G. M. T. equals 12+5 or 17 hours (+) of April 25. For this instant of time the mean sun is plotted at S_m.

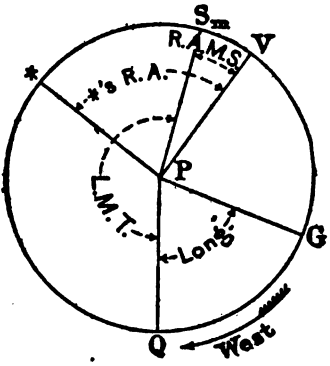

FIG. 42.

Now the problem is, knowing the positions of G, Q, and S_m, to find the position of the given star on the diagram, and thence its local hour angle. If we can find the relative angles from the mean sun and from the star to some third object, we can plot this third object and find the required hour angle of the star. The third object is the First Point of Aries (the Vernal Equinox) and the angles from the mean sun and from the star are the right ascensions of the mean sun and the star. The right ascension of the mean sun is found from the Almanac, not for the instant we want, but for the Greenwich mean noon of the date. This R. A. must be increased by a correction for the angle through which the mean sun has traveled since noon, – the G. M. T. In the problem the R. A. M. S. so increased is 2 hours, so we lay off S_mV from S_m to the westward 2 hours, plotting the position of the Vernal Equinox at the desired instant. From the Almanac we find the R. A. of the star to be 6 hours, and we lay off V ∗ equal to 6 hours to the eastward. The required local hour angle of the star is then Q ∗ which equals QS_m+ VS_m – V ∗ equals L. M. T.+R. A. M. S.–R. A. equals $12^h+2^h-6^h$ equals 8 hours.

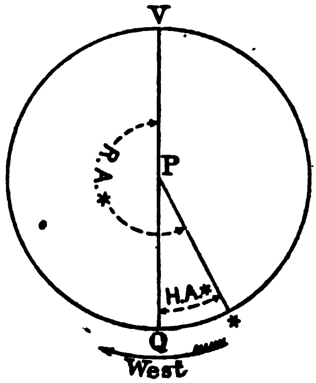

FIG. 43.

SECOND EXAMPLE OF ARTICLE 293. (SEE FIGURE 43.)

Draw the figure as before. The problem is, knowing the position of the star at a certain instant, to find the L. S. T., so we must plot the position of the star, then that of the Vernal Equinox. The local hour angle of the latter is the required L. S. T.

The hour angle of the star is given as 2 hours, bearing east from the meridian, so lay off Q ∗ = 2 hours to the east from Q. Now find from the Almanac the R. A. of the ∗ which is 14 hours, and lay off ∗ V equal to 14^h to the westward from ∗. The L. S. T. is then QV, equals V ∗ – Q ∗, equals the R. A. ∗ – H. A. ∗, equals 14^h-2^h equals 12 hours.

When doubt exists as to the Greenwich date the navigator, by plotting the data in exactly the same way as explained above, can at once remove all doubt on the subject and can get the correct G. M. T.

CHAPTER X.

CORRECTION OF OBSERVED ALTITUDES.

294. The *true altitude* of a heavenly body at any place on the earth's surface is the altitude of its center, as it would be measured by an observer at the center of the earth, above the plane passed through the center of the earth at right angles to the direction of the zenith.

The *observed altitude* of a heavenly body, as measured at sea, may be converted to the true altitude by the application of the following-named corrections: *Index Correction, Dip, Refraction, Parallax,* and *Semidiameter*. The corrections for parallax and semidiameter are of inappreciable magnitude in observations of the fixed stars, and with planets are so small that they need only be regarded in refined calculations. In observations with the artificial horizon there is no correction for dip.

For theoretical accuracy, the corrections should be applied in the order in which they are named, but in ordinary nautical practice the order of application makes no material difference, except in the case of the parallax of the moon as explained in article 306; and hence, instead of turning to the separate tables referred to in the following articles as containing these corrections, their combined amount, given in Table 46, may be applied to observed altitudes of the sun, the planets, and the stars, after the manner shown in article 308.

INDEX CORRECTION.

295. This correction is fully explained in articles 249 and 250, Chapter VIII.

REFRACTION.

296. It is known by various experiments that the rays of light deviate from their rectilinear course in passing obliquely from one medium into another of a different density; if the latter be more dense, the ray will be bent toward the perpendicular to the line of junction of the media; if less dense, it will be bent away from that perpendicular.

The ray of light before entering the second medium is called the *incident* ray; after it enters the second medium it is called the *refracted* ray, and the difference of direction of the two is called the *refraction*.

The rays of light from a heavenly body must pass through the atmosphere before reaching the eye of an observer upon the surface of the earth. The earth's atmosphere is not of a uniform density, but is most dense near the earth's surface, gradually decreasing in density toward its upper limit; hence the path of a ray of light, by passing from a rarer medium into one continually increasing density becomes a curve, which is concave toward the earth. The last direction of the ray is that of a tangent to the curved path at the eye of the observer, and the difference of the direction of the ray before entering the atmosphere and this last direction constitutes the refraction.

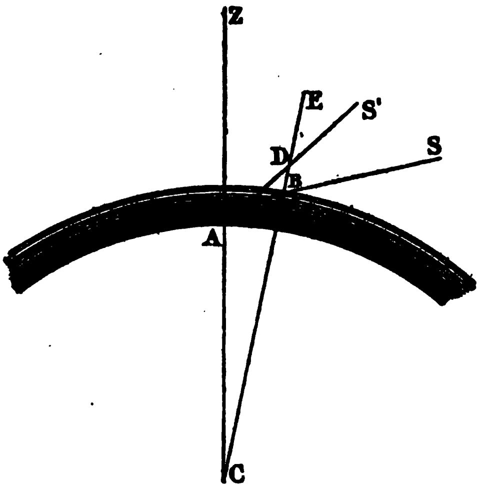

FIG. 44.

297. To illustrate this, consider the earth's atmosphere as shown in figure 44; let SB be a ray from a star S, entering the atmosphere at B, and bent into the curve BA; then the apparent direction of the star is AS′, the tangent to the curve at the point A, the refraction being the angle between the lines BS and AS′. If CAZ is the vertical line of the observer, by a law of optics the vertical plane of the observer which contains the tangent AS′ must also contain the whole curve BA and the incident ray BS. Hence refraction increases the apparent altitude of a star without affecting its azimuth.

At the zenith the refraction is nothing. The less the altitude the more obliquely the rays enter the atmosphere and the greater will be the refraction. At the horizon the refraction is the greatest.

298. The refraction for a mean state of the atmosphere (barometer 30$^{\text{in}}$, Fahr. thermometer 50°) is given in Table 20 A; the combined refraction and sun's parallax in Table 20 B; and the combined refraction and moon's parallax in Table 24.

Since the amount of the refraction depends upon the density of the atmosphere, and the density varies with the pressure and the temperature, which are indicated by the barometer and thermometer, the *true* refraction is found by applying to the mean refraction the corrections to be found in Tables 21 and 22; these are deduced from Bessel's formulæ, and are regarded as the most reliable tables constructed. It should be remembered, however, that under certain conditions of the atmosphere a very extraordinary deflection occurs in rays of light which reach the observer's eye from low altitudes (that is, from points near the visible horizon), the amount of which is not covered by the ordinary corrections for pressure and temperature; the error thus created is discussed under *Dip* (art. 301); on account of it, altitudes less than 10° should be avoided.

EXAMPLE: Required the refraction for the apparent altitude 5°, when the thermometer is at 20° and the barometer at 30$^{\text{in}}$.67.

The mean refraction by Table 20 A is,	9′ 52″
The correction for height of barometer is,	+ 13
The correction for the temperature,	+ 42
True refraction,	10 47

299. The correction for refraction should always be subtracted, as also that for combined refraction and parallax of the sun; the correction for combined refraction and parallax of the moon is invariably additive.

DIP.

300. *Dip of the Horizon* is the angle of depression of the visible sea horizon below the true horizon, due to the elevation of the eye of the observer above the level of the sea.

In figure 45 suppose A to be the position of an observer whose height above the level of the sea is AB. CAZ is the true vertical at the position of the observer, and AH is the direction of the true horizon, S being an observed heavenly body. Draw ATH′ tangent to the earth's surface at T. Disregarding refraction, T will be the most distant point visible from A. Owing to refraction, however, the most distant visible point of the earth's surface is more remote from the observer than the point T, and is to be found at a point T′, in figure 46. But to an observer at A the point T′ will appear to lie in the direction of AH″, the tangent at A to the curve AT′. If the vertical plane were revolved about CZ as an axis, the line AH would generate the plane of the true horizon, while the point T′ would generate a small circle of the terrestrial sphere called the *Visible* or *Sea Horizon*. The *Dip of the Horizon* is HAH″, being the angle between the true horizon and the apparent direction of the sea horizon. Values of the dip are given in Table 14 for various heights of the observer's eye, and in the calculation of the table allowance has been made for the effect of atmospheric refraction as it exists under normal conditions.

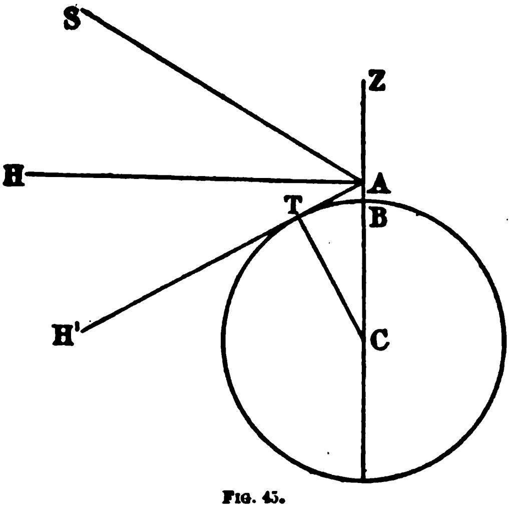

FIG. 45.

301. The fact must be emphasized, however, that under certain conditions the deflection of the ray in its path from the horizon to the eye is so irregular as to give a value of the dip widely different from that which is tabulated for the mean state of atmosphere. These irregularities usually occur when there exists a material difference between the temperature of the sea water and that of the air, and they attain a maximum value in calm or nearly calm weather, when the lack of circulation permits the air to arrange itself in a series of horizontal strata of different densities, the denser strata being below when the air is warmer, and the reverse condition obtaining when the air is cooler. The effect of such an arrangement is that a ray of light from the horizon in passing through media of different densities, undergoes a refraction quite unlike that which occurs in the atmosphere of much more nearly homogeneous density that exists under normal conditions.

Various methods have been suggested for computing the amount of dip for different relative values of temperature of air and water, but none of these afford a satisfactory solution, there being so many elements involved which are not susceptible of determination by an observer on shipboard that it will always be difficult to arrive at results that may be depended upon.

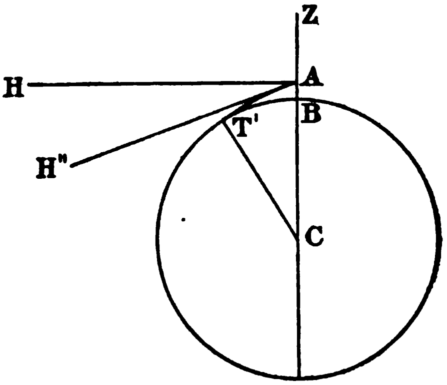

FIG. 46.

As the amount of difference between the actual and tabulated values of the dip due to this cause may sometimes be very considerable—reliable observations having frequently placed it above 10′, and values as high as 32′ having been recorded—it is necessary for the navigator to be on his guard against the errors thus produced, and to recognize the possible inaccuracy of all results derived from observations taken under unfavorable conditions. Without attempting to give any method for the determination of the amount of the extraordinary variation in dip, the following rules may indicate to the navigator the conditions under which caution must be observed, and the direction of probable error:

(*a*) A displacement of the horizon should always be suspected when there is a marked difference between the temperatures of air and sea water; this fact should be especially kept in mind in regions such as those of the Red Sea and the Gulf Stream, where the difference frequently exists.

(*b*) The error in the tabulated value of the dip will increase with an increase in the difference of temperature, and will diminish with an increase in the force of the wind.

(*c*) The error will decrease with the height of the observer's eye; hence it is expedient, especially when error is suspected, to make the observation from the most elevated position available.

(*d*) When the sea water is colder than the air the visible horizon is raised and the dip is decreased; therefore the true altitude is greater than that given by the use of the ordinary dip table. When the water is warmer than the air, the horizon is depressed and the dip is increased. At such times the altitude is really less than that found from the use of the table.

The same cause, it may be mentioned here, affects the kindred matter of the visibility of objects. When the air is warmer, terrestrial objects are sighted from a greater distance and appear higher above the horizon than under ordinary conditions. When the water is warmer than the air, the distance of visibility is reduced, and terrestrial objects appear at a less altitude.

302. What has been said heretofore about the dip supposes the horizon to be free from all intervening land or other objects; but it often happens that an observation is required to be taken from a ship sailing along shore or at anchor in harbor, when the sun is over the land and the shore is nearer the ship than the visible sea horizon would be if it were unconfined; in this case the dip will be different from that of Table 14, and will be greater the nearer the ship is to that point of the shore to which the sun's image is brought down. In such case Table 15 gives the dip at different heights of the eye and at different distances of the ship from the land.

303. The dip is always to be subtracted from the observed altitude.

PARALLAX.

304. The *parallax* of a heavenly body is, in general terms, the angle between two straight lines drawn to the body from different points. But in Nautical Astronomy *geocentric parallax* is alone considered, this being the difference between the positions of a heavenly body as seen at the same instant from the center of the earth and from a point on its surface.

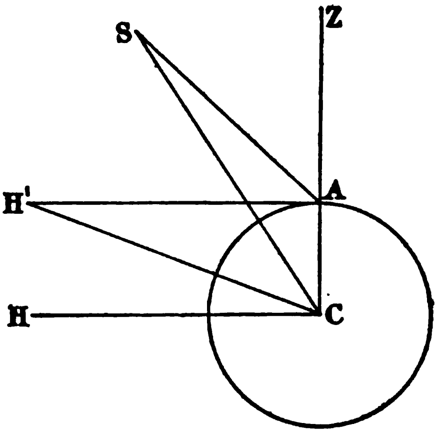

FIG. 47.

The zenith distance of a body, S (fig. 47), seen from A, on the surface of the earth, is ZAS; seen from C it is ZCS; the *parallax* is the difference of these angles, ZAS − ZCS = ASC.

Parallax in altitude is, then, the angle at the heavenly body subtended by the radius of the earth.

If the heavenly body is in the horizon as at H′, the radius, being at right angles to AH′, subtends the greatest possible angle at the star for the same distance, and this angle is called the *horizontal parallax.* The parallax is less as the bodies are farther from the earth, as will be evident from the figure.

Let par. = parallax in altitude, ASC;
Z = SAZ, the apparent zenith distance (corrected for refraction);
R = AC, the radius of the earth; and
D = CS, the distance of the object from the center of the earth.

Then, since SAC = 180° − SAZ, the triangle ASC gives:

$$\sin \text{par.} = \frac{R \sin Z}{D}.$$

If the object is in the horizon at H′, the angle AH′C is the horizontal parallax, and denoting it by H. P. the right triangle AH′C gives:

$$\sin \text{H. P.} = \frac{R}{D}.$$

Substituting this value of $\frac{R}{D}$ in the above,

$$\sin \text{par.} = \sin \text{H. P.} \sin Z.$$

If h = SAH′, the apparent altitude of the heavenly body, then $Z = 90° - h$; hence,

$$\sin \text{par.} = \sin \text{H. P.} \cos h.$$

Since par. and H. P. are always small, the sines are nearly proportional to the angles; hence,

$$\text{par.} = \text{H. P.} \cos h.$$

305. The Nautical Almanac gives the horizontal parallax of the moon, as well as of the planets Venus, Mars, Jupiter, and Saturn.

In Table 16 will be found the values of the sun's parallax for altitude intervals of 5° or 10°, while Table 20 B contains the combined values of the sun's parallax and the refraction. In Table 24 is given the parallax of the moon, combined with the refraction, at various altitudes and for various values of the horizontal parallax.

306. Parallax is always additive; combined parallax and refraction additive in the case of the moon, but subtractive for the sun.

As the correction for parallax of the moon is so large, it is essential that it be taken from the table with considerable accuracy; the corrections for index correction, semidiameter, and dip should therefore be applied first, and the "approximate altitude" thus obtained should be used as an argument in entering Table 24 for parallax and refraction.

SEMIDIAMETER.

307. The *semidiameter* of a heavenly body is half the angle subtended by the diameter of the visible disk at the eye of the observer. For the same body the semidiameter varies with the distance; thus, the difference of the sun's semidiameter at different times of the year is due to the change of the earth's distance from the sun; and similarly for the moon and the planets.

In the case of the moon, the earth's radius bears an appreciable and considerable ratio to the moon's distance from the center of the earth; hence the moon is materially nearer to an observer when in or near his zenith than when in or near his horizon, and therefore the semidiameter, besides having a menstrual change, has a semidiurnal one also.

The increase of the moon's semidiameter due to increase of altitude is called its *augmentation*. This reduction may be taken from Table 18.

The semidiameters of the sun, moon, and planets are given in their appropriate places in the Nautical Almanac.

The semidiameter is to be added to the observed altitude in case the lower limb of the body is brought into contact with the horizon, and to be subtracted in the case of the upper limb. When the artificial horizon is used, the limb of the *reflected* image is that which determines the sign of this correction, it being additive for the lower and subtractive for the upper.

EXAMPLE: May 6, 1916, the observed altitude of the sun's upper limb was 62° 10′ 40″; I. C., + 3′ 10″; height of the eye, 25 feet. Required the true altitude.

Obs. alt. $\overline{\odot}$,		62° 10′ 40″	I. C.,	+	3′ 10″
Corr.,	−	18 04			
			S. D. (Naut. Alm.),	−	15′ 53″
True alt.,		61 52 36	dip (Tab. 14),	−	4 54
			p. & r. (Tab. 20 B),	−	27
				−	21 14
			Corr.,	−	18′ 04″

EXAMPLE: The altitude of Sirius as observed with an artificial horizon was 50° 59′ 30″; I. C., − 1′ 30″. Required the true altitude.

Obs. 2 alt. *,		50° 59′ 30″
I. C.,	−	1 30
		2)50 58 00
Obs. alt.,		25 29 00
ref. (Tab. 20 A),	−	2 02
True alt.,		25 26 58

EXAMPLE: April 16, 1916, observed altitude of Venus 53° 26′ 10″; I. C., + 2′ 30″; height of eye, 20 feet. Required the true altitude.

Obs. alt. *,	53° 26′ 10″	par. (Tab. 17),	+	0′ 06″	Hor. Par. (Naut. Alm.), 11″.4
Corr., —	2 30	I. C.,	+	2 30	
	53 23 40		+	2 36	
		dip (Tab. 14),	−	4′ 23″	
		ref. (Tab. 20 A),	−	43	
			−	5 06	
		Corr.,	−	2′ 30″	

Example: May 6, 1916, at 13ʰ 24ᵐ G. M. T., the observed altitude of the moon's lower limb was 25° 30′ 30″; I. C., −1′ 30″; height of eye, 20 feet. Required the true altitude.

Obs. alt. ☾,	25° 30′ 30″	S. D. (Naut. Alm.),	+14′ 48″	Hor. Par. (Naut. Alm.), 54′ 06″
1st corr.,	+ 9 01	Aug. (Tab. 18),	+ 06	
Approx. alt.,	25 39 31		+14 54	
p. & r. (Tab. 24),	+ 46 45	dip. (Tab. 14),	− 4′ 23″	
True alt.,	26 26 16	I. C.,	− 1 30	
			− 5 53	
		1st corr.,	+ 9′ 01″	

Or, the following modification may be adopted:

Obs. alt. ☾,	25° 30′ 30″	S. D.,	+14′ 48″	H. P.,	3246″	log.	3.51135
1st corr.,	+ 6 59	Aug.,	+ 06	App. alt.,	25° 38′	cos	9.95504
Approx. alt.,	25 37 29		+14 54	par.,	2927″ 48′ 47″	log.	3.46639
par.,	+ 48 47	dip.,	− 4′ 23″				
True alt.,	26 26 16	ref.,	− 2 02				
		I. C.,	− 1 30				
			− 7 55				
		1st corr.,	+ 6′ 59″				

308. The corrections for dip, parallax, refraction, and semidiameter, which must be applied to the observed altitude of a star or of the sun's lower limb in order to obtain the true altitude, have been combined in Table 46, and for the moon's upper and lower limb in Table 49, and will henceforth be used in all subsequent problems. This is done in order to save the time and labor involved in referring to separate tables of these corrections.

The tabulated correction for an observed altitude of a star combines the mean refraction and the dip; and that for the observed altitude of the sun's lower limb, the mean refraction, the dip, the parallax, and the mean semidiameter, which is taken as 16′. A supplementary table, taking account of the variation of the sun's semidiameter in the different months of the year, is given in connection with the main table.

Thus, in the first example under article 324, we may, when variations from the mean state of the atmosphere (barometer 30 inches, Fahr. thermometer 50°) are left out of consideration, proceed as follows:

Measured altitude.................................. ☉ =		40° 04′ 00″
I. C. = +		3 00
Correction from Table 46, height of eye 20 feet.	+10′ 35″	40 07 00
Supplementary table for June 21	− 0 14	10 21
True altitude......................................		40 17 21

CHAPTER XI.

THE CHRONOMETER ERROR.

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309. It has already been explained (art. 261, Chap. VIII) that the *error* of a chronometer is the difference between the time indicated by it and the correct standard time to which it is referred; and that the *daily rate* is the amount that it gains or loses each day. In practice, chronometer errors are usually stated with reference to Greenwich mean time. It is not required that either the error or the rate shall be zero, but in order to be enabled to determine the correct time it is essential that both rate and error be known and that the rate shall have been uniform since its last determination.

310. Determining the Rate.—Since all chronometers are subject to some variation in rate under the changeable conditions existing on shipboard, it is desirable to ascertain a new rate as often as possible. The process of obtaining a rate involves the determination of the error on two different occasions separated by an interval of time of such length as may be convenient; the change of error during this interval, divided by the number of days, gives the daily rate.

Example: On March 10, at noon, found chronometer No. 576 to be $0^{m}\ 32^{s}.5$ fast of G. M. T.; on March 20, at noon, the same chronometer was $0^{m}\ 48^{s}.0$ fast of G. M. T. What was the rate?

Error, March $10^{d}\ 0^{h}$,	-	$+0^{m}\ 32^{s}.5$
Error, March $20^{d}\ 0^{h}$,	-	$+0\ \ 48\ .\ 0$
Change in 10 days,	-	$+\ \ 15\ .\ 5$
Daily rate,	-	$+\ \ 1^{s}.55$

The chronometer is therefore *gaining* $1^{s}.55$ per day.

311. Determining Error from Rate.—The error on any given day being known, together with the daily rate, to find the error on any other day it is only necessary to multiply the rate by the number of days that may have elapsed and to apply the product with proper sign to the given error.

Example: On December 17 a chronometer is $3^{m}\ 27^{s}.5$ slow of G. M. T. and losing $0^{s}.47$ daily. What is the error on December 26?

Error Dec. 17,	$-3^{m}\ 27^{s}.5$	Daily rate,	$-0^{s}.47$
Correction,	$-\ \ 4\ .2$	No. days,	9
Error Dec. 26,	$-3\ \ 31\ .7$	Corr.,	$-4\ .23$

The chronometer is therefore *slow* of G. M. T. on December 26, $3^{m}\ 31^{s}.7$.

312. It is necessary to distinguish between the signs of the chronometer *correction* and of the chronometer *error*. A chronometer fast of the standard time is considered as having a *positive error*, since its readings are positive to (greater than) those of an instrument showing correct time; but the same chronometer has a *negative correction*, as the amount must be subtracted to reduce chronometer readings to correct readings.

313. Numerous methods are available for determining the error of a chronometer in port. The principal of these will be given.

BY TIME SIGNALS.

314. In nearly all of the important ports of the world a time signal is made each day at some defined instant. In many cases this consists in the dropping of a time ball—the correct instant being given telegraphically from an observatory. In a number of places where there is no time ball a signal may be received on the instruments at the telegraph offices, whereby mariners may ascertain the errors of their chronometers. Such signals are to be had in almost every port of the United States, and similar signals are being sent out from Government radio stations, so that it is now possible to find the error of the chronometer on board ships fitted with receiving instruments when lying in port and also when underway within radio distance of these stations.

The time signal may be given by a gunfire or other sound, in which case allowance must be made by the observer for the length of time necessary for the sound to travel from the point of origin to his position. Sound travels 1,090 feet per second at 32° F., and its velocity increases at the rate of 1.15 feet per second with each degree increase of temperature. If V be the velocity of sound in feet per second at the existing temperature, and D the distance in feet to be traversed, $\frac{D}{V}$ is the number of seconds to be subtracted from the chronometer reading at the instant of hearing the signal to ascertain the reading at the instant the signal was made.

This method of obtaining the chronometer error consists in taking the difference between the standard time and chronometer time at the time of observation and marking the result with appropriate sign.

Example: A time ball drops at $5^h\ 0^m\ 0^s$, G. M. T., and the reading of a chronometer at the same moment is $4^h\ 57^m\ 52^s.5$. What is the chronometer error?

G. M. T.,		$5^h\ 00^m\ 00^s$
Chro. t.,		4 57 52.5
Chro. error,	−	2 07.5

That is, chronometer is *slow* $2^m\ 07^s.5$; chronometer *correction* additive.

BY TRANSITS.

315. The most accurate method of finding the chronometer correction is by means of a transit instrument well adjusted in the meridian, noting the times of transit of a star or the limbs of the sun across the threads of the instrument.

At the instant of the body's passage over the meridian wire, mark the time by the chronometer. The hour angle at the instant is 0^h; therefore the local sidereal time is equal to the right ascension of the body in the case of a star, or the local apparent time is 0^h in the case of the sun's center. By converting this sidereal or apparent time into the corresponding mean time and applying the longitude, the Greenwich mean time of transit is given. By comparing with this the time shown by chronometer the error is found.

Example: 1916, May 9 (Ast. day), in Long. 44° 39′ E., observed the transit of Arcturus over the middle wire of the telescope, the time noted by a chronometer regulated to Greenwich mean time being $8^h\ 05^m\ 33^s.5$. Required the error.

L. S. T. (R. A. ✱),		$14^h\ 11^m\ 52^s.9$
Long.,	−	2 58 36
G. S. T.,		11 13 16.9
R. A. M. S., $9^d\ 0^h$,	−	3 07 51.8
Sid. int. from 0^h,		8 05 25.1
Reduction (Tab. 8),	−	1 19.5
G. M. T.,		8 04 05.6
Chro. t.,		8 05 33.5
Chro. fast,		1 27.9

Example: June 25, 1916, in Long. 60° E., observed the transit of both limbs of the sun over the meridian wire of the telescope, noting the times by a chronometer. Find the error of the chronometer on G. M. T.

Transit of western limb,		$8^h\ 04^m\ 02^s.5$
Transit of eastern limb,		8 06 20.0
Chro. time, loc. app. noon,		8 05 11.25
L. A. T., loc. app. noon,		$0^h\ 00^m\ 00^s$
Eq. t.,	+	2 19.1
L. M. T., loc. app. noon,		0 02 19.1
Long.,	−	4 00 00
G. M. T., loc. app. noon,		8 02 19.1
Chro. time, loc. app. noon,		8 05 11.25
Chro. fast,		2 52.15

Eq. t., $24^d\ 20^h$., $2^m\ 19^s.1$
Add to *apparent* time.

BY A SINGLE ALTITUDE (TIME SIGHT).

316. The problem involved in this solution, by reason of its frequent application in determining the longitude at sea, is one of the most important ones in Nautical Astronomy. It consists in finding the hour angle from given values of the altitude, latitude, and polar distance. The hour angle thus obtained is ~~converted by means~~ of the longitude and equation of time in the case of the sun, or longitude and right ascension in the case of other celestial bodies, into Greenwich mean time; and this, compared with the chronometer time, gives the error.

317. It should be borne in mind that the most favorable position of the heavenly body for time observations is when near to the prime vertical. When exactly in the prime vertical a small error in the latitude produces no appreciable effect. Therefore, if the latitude is uncertain, good results may be obtained by observing the sun or other body when bearing east or west. If observations are made at the same or nearly the same altitude on each side of the meridian and the mean of the results is taken, various errors are eliminated of which it is otherwise impossible to take account, and a very accurate determination is thus afforded.

318. With a sextant and artificial horizon or good sea horizon, several altitudes of a body should be observed in quick succession, noting in each case the time as shown by a hack chronometer or comparing watch whose error upon the standard chronometer is known. Condensing the observation into a brief interval justifies the assumption that the altitude varies uniformly with the time. A very satisfactory method is to set the sextant in advance at definite intervals of altitude and note the time as contact is observed.

319. Correct the observed altitude for instrumental and other errors, reducing the apparent to the true altitude.

If the sun, the moon, or a planet is observed, the declination is to be taken from the Nautical Almanac for the time of the observation. If the chronometer correction is not approximately known and it is therefore impossible to determine the Greenwich mean time of observation with a fair degree of accuracy, the first hour angle found will be an approximate one; the declination corrected by this new value of the time will produce a more exact value of the hour angle, and the operation may be repeated until a sufficiently precise value is determined.

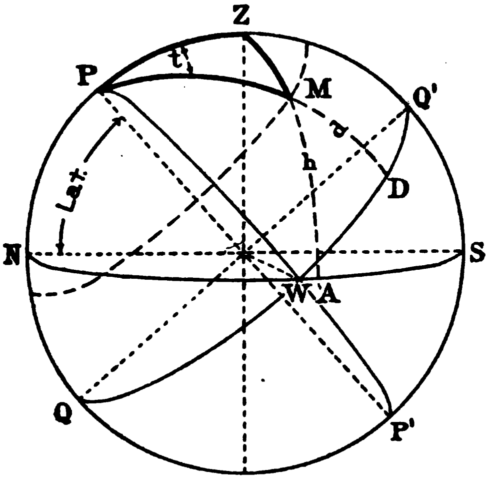

FIG. 48.

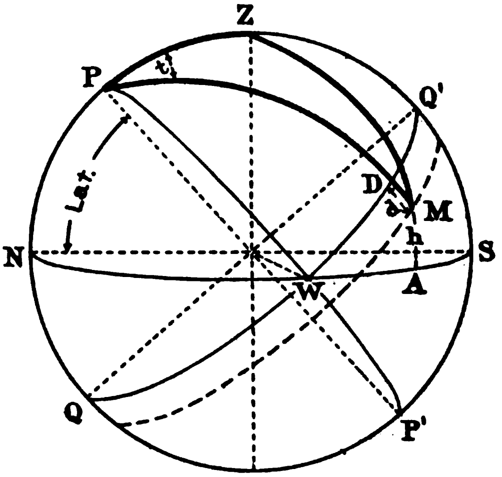

FIG. 49.

320. In figures 48 and 49 are given:

AM = h, the altitude of the body M;

DM = d, the declination; and

Q'Z = L, the latitude of the place.

In the astronomical triangle PMZ there may be found from the foregoing:

ZM = z, the zenith distance of the body, = $90° - h$;

PM $= p$, the polar distance, $= 90° \pm d$; and
PZ $=$ co.L, the co-latitude of the place, $= 90° - L$.

From these data it is required to find the angle MPZ the hour angle of the body, $= t$. This is given by the formula:

$$\left(\sin^2 \tfrac{1}{2} t = \frac{\cos \frac{1}{2} (h + L + p) \sin \frac{1}{2} (L + p - h)}{\cos L \sin p} . \right)$$

If we let $s = \frac{1}{2} (h + L + p)$, this becomes:

$$\sin \tfrac{1}{2} t = \sqrt{\sec L \operatorname{cosec} p \cos s \sin (s - h)}.$$

The polar distance is obtained by adding the declination to 90° when of different name from the latitude and subtracting it from 90° when of the same name. Like latitude and altitude, it is always positive.

If the sun is the body observed, the resulting hour angle is the local apparent time and is to be taken from the a. m. or p. m. column of Table 44 according as the altitude is observed in the forenoon or afternoon. If the moon, a star, or a planet be taken, the hour angle is always found in the p. m. column.

Local apparent time as deduced from an observation of the sun is converted to local mean time by the application of the equation of time; then, by adding the longitude if west and subtracting it if east, the Greenwich mean time is obtained.

The hour angle of any other body, added to its right ascension when it is west of the meridian at observation or subtracted therefrom when east, gives the local sidereal time, which may be reduced to Greenwich sidereal time by the application of the longitude, and thence to Greenwich mean time by methods previously explained.

A comparison of the Greenwich mean time with the chronometer time of sight gives the error of the chronometer.

Example: January 20, 1916, p. m., in Lat. 48° 41′ 00″ S., Long. 69° 03′ 00″ E., observed a series of altitudes of the sun with a sextant and artificial horizon; mean double altitude, 59° 08′ 10″, images approaching; mean of times by comparing watch, $4^h\ 40^m\ 56^s$; C—W, $7^h\ 23^m\ 25^s$; index correction, −1′ 30″; approximate chronometer correction, $-0^m\ 10^s$. What was the exact chronometer error?

W. T.,	$4^h\ 40^m\ 56^s$
C—W,	7 23 25
Chro. t.,	0 04 21
App. C. C.,	− 0 10
App. G. M. T.,	0 04 11

Obs. 2 alt. ☉		59° 03′ 10″
I. C.,	−	1 30
		2)59 01 40
☉		29 30 50
Corr.,	+	14 43
h,		29 45 33
S. D.,	+	16′ 17″
$p.$ & $r.$,	−	1′ 34″
Corr.,	+	14′ 43″

Dec. 0^h.,		20° 20′.8 S.
H. D.,	−	0′.5
G. M. T.,		$0^h.07$
Corr.,	−	0′.035
Dec.,		20° 20′ 46″ S.
p.,		69° 39′ 14″

Eq. t. 0^h,		$10^m\ 51^s.7$
H. D.,	+	$0^s.7$
G. M. T.,		$0^h.07$
Corr.,	+	$0^s.049$
Eq. t., $0^h\ 4^m\ 11^s$,		$10^m\ 51^s.8$

(*Add to apparent time.*)

h	29° 45′ 33″		
L	48 41 00	sec	.18031
p	69 39 14	cosec	.02798
	2)148 05 47		
s	74 02 54	cos	9.43906
$s-h$	44 17 21	sin	9.84403
			2)19.49138
L. A. T.,	$4^h\ 30^m\ 40^s.4$	sin ½ t	9.74569

L. A. T.,	$4^h\ 30^m\ 40^s.4$
Eq. t.,	+ 10 51.8
L. M. T.,	4 41 32.2
Long.,	−4 36 12.0
G. M. T.,	0 05 20.2
Chro. t.,	0 04 21.0
Chro. slow,	0 00 59.2

Example: May 18, 1916, p. m., in Lat. 8° 03′ 22″ S., Long. 34° 51′ 57″ W., observed a series of altitudes of the star Arcturus, east of the meridian, using artificial horizon; mean double altitude, 60° 10′; mean watch time, $6^h\ 50^m\ 32^s$; C—W, $2^h\ 20^m\ 59^s.5$; I. C., +2′ 00″. Find the true error of the chronometer.

W. T.,	$6^h\ 50^m\ 32^s$	Obs. 2 alt. ✱,		60° 10′ 00″	R. A. ✱,	$14^h\ 11^m\ 52^s.9$
C—W,	2 20 59.5	I. C.,	+	2 00	Dec. ✱,	19° 36′ 54″ N.
Chro. t.,	9 11 31.5			2)60 12 00	*p*,	109° 36′ 54″
				30 06 00		
		ref.,	−	1 40		
		h,		30 04 20		

h	30° 04′ 20″			R. A. ✱,	$14^h\ 11^m\ 52^s.9$
L	8 03 22	sec	.00431	H. A.,	− 3 36 01.3
p	109 36 54	cosec	.02596	L. S. T.,	10 35 51.6
	2)147 44 36			Long.,	+ 2 19 27.8
s	73 52 18	cos	9.44372	G. S. T.,	12 55 19.4
s—h	43 47 58	sin	9.84019	R. A. M. S., 0^h,	− 3 43 20.8
			2)19.31418	Sid. int. from 0^h,	9 11 58.6
H. A.,	$3^h\ 36^m\ 01^s.3$ E.	sin ½ *t*	9.65709	Red. (Tab. 8),	− 1 30.4
				G. M. T.,	9 10 28.2
				Chro. t.,	9 11 31.5
				Chro. fast,	1 03.3

BY DOUBLE ALTITUDES OR ALTITUDES ON OPPOSITE SIDES OF THE MERIDIAN.

320. Instead of relying on a single determination of the chronometer error from altitudes on one side of the meridian, it is better to observe the same body on both sides of the meridian, and, if possible, at about the same altitude. The error of the chronometer having been found from each set of sights, the mean is taken as the correct error, and this mean will probably be nearer the true error than the result from either set; the effect of the constant errors of latitude, instrument, and observer, being opposite in the two cases, will be eliminated by taking the mean.

CHAPTER XII.

LATITUDE.

BY MERIDIAN ALTITUDE.

321. The latitude of a place on the surface of the earth, being its angular distance from the equator, is measured by an arc of the meridian between the zenith and the equator, and hence is equal to the declination of the zenith; therefore, if the zenith distance of any heavenly body when on the meridian be known, together with the declination of the body, the latitude can be found.

Let figure 50 represent a projection of the celestial sphere on the plane of the meridian NZS; O, the center of the sphere; NS, the horizon; P and P′, the poles of the sphere; QOQ′, the equator; Z, the zenith of the observer. Then, by the above definition, ZQ will be the latitude of the observer; and NP, the altitude of the elevated pole, will also equal the latitude.

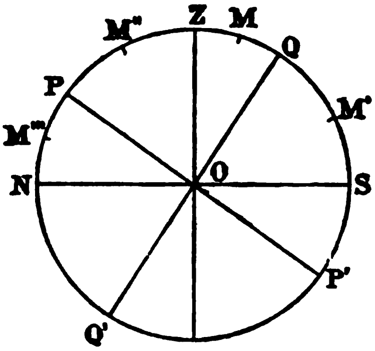

FIG. 50.

Let M be the position of a heavenly body north of the equator, but south of the zenith; $QM = d$, its declination; $MS = h$, its altitude; and $ZM = z = 90° - h$, its zenith distance.

From the figure we have:

$$QZ = QM + MZ, \text{ or}$$
$$L = d + z.$$

By attending to the names of z and d, marking the zenith distance north or south according as the zenith is north or south of the body, the above equation may be considered general for any position of the body at upper transit, as M, M′, M″.

In case the body is below the pole, as at M‴—that is, at its lower culmination—the same formula may be used by substituting $180° - d$ for d. Another solution is given in this case by observing that:

$$NP = PM''' + NM''', \text{ or}$$
$$L = p + h.$$

322. A common practice at sea is to commence observing the altitude of the sun's lower limb above the sea horizon about 10 minutes before noon, and then, by moving the tangent-screw, to follow the sun as long as it rises; as soon as the highest altitude is reached, the sun begins to fall and the lower limb will appear to *dip*. When the sun dips the reading of the limb is taken, and this is regarded as the meridian observation.

It will, however, be found more convenient, and frequently more accurate, for the observer to have his watch set for the local apparent time of the prospective noon longitude, or to know the error of the watch thereon, and to regard as the *meridian* altitude that one which is observed when the watch indicates noon. This will save time and try the patience less, for when the sun transits at a low altitude it may remain "on a stand," without appreciable decrease of altitude for several minutes after noon; moreover, this method contributes to accuracy, for when the conditions are such that the motion in altitude due to change of hour angle is a slow one, the motion therein due to change of the observer's latitude may be very material, and thus have considerable influence on the time of the sun's dipping. This error is large enough to take account of in a fast-moving vessel making a course in which there is a good deal of northing or southing.

In observing the altitude of any other heavenly body than the sun, the watch time of transit should previously be computed and the meridian altitude taken by time rather than by the dip. This is especially important with the moon, whose rapid motion in declination may introduce still another element of inaccuracy.

323. The watch time of transit for the sun, or other heavenly body, may be found by the forms given below, knowing the prospective longitude, the chronometer error, and the amount that the watch is slow of the chronometer. In this connection, article 404 describing the method of setting the watch to L. A. T. may be profitably read.

For the Sun.			*For other Bodies.*		h m s
L. A. T. noon,		$0^{h}\ 00^{m}\ 00^{s}$	L. S. T. transit,		(Right ascension.)
Long. (+if west),	±	______	Long. (+if west),	±	______
G. A. T.,			G. S. T.,		
Eq. t.,	±	______	R. A. M. S., 0^{h},	−	______
G. M. T.,			Sid int. from 0^{h},		
C. C. (sign reversed),	∓	______	Red. (Tab. 8),	−	______
Chro. time,			G. M. T.,		
C—W,	−	______	C. C. (sign reversed),	∓	______
Watch time noon,			Chro. time,		
			C—W,	−	______
			Watch time transit,		

324. From the observed altitude deduce the true altitude, and thence the true zenith distance. Mark the zenith distance North if the zenith is north of the body when on the meridian, South if the zenith is south of the body.

Take out the declination of the body from the Nautical Almanac for the time of meridian passage, having regard for its proper sign or name.

The algebraic sum of the declination and zenith distance will be the latitude. Therefore, add together the zenith distance and the declination if they are of the same name, but take their difference if of opposite names; this sum or difference will be the latitude, which will be of the same name as the greater.

Example: At sea, June 21, 1916, in Long. 60° W., the observed meridian altitude of the sun's lower limb was 40° 4′; sun bearing south; I. C., +3′ 0″; height of the eye, 20 feet; required the latitude.

Obs. alt.,	40° 04′ 00″	(Tab. 46),	+10′ 21″	Dec.,	23° 27′.1 N.	G. A. T.,	$4^{h}\ 00^{m}\ 00^{s}$
Corr.,	+ 13 21	I. C.,	+ 3 00			Eq. t.,	1 31 .7
				H. D.,	0 .0		
h,	40 17 21	Corr.,	+13′ 21″			G. M. T.,	4 01 31 .7
z,	49° 42′ 39″ N.					Eq. t., 4^{h}	$1^{m}\ 31^{s}.7$
d,	23 27 06 N.					(Add to app. time.)	
L,	73 00 45 N.						

Example: At sea, April 14, 1916, in Long. 140° E., the observed meridian altitude of the sun's lower limb was 81° 15′ 30″; sun bearing north; I. C., −2′ 30″; height of the eye, 20 feet.

Obs. alt.,	81° 15′ 30″	(Tab. 46),	+11′ 30″	Dec., $13^{d}\ 14^{h}$,	9° 14′.4 N.	G. A. T.,	$13^{d}\ 14^{h}\ 40^{m}\ 00^{s}$	Eq. t., $13^{d}\ 14^{h}$,	$0^{m}\ 26^{s}.6$
Corr.,	+ 9 00	I. C.,	− 2 30			Eq. t.,	+ 26 .2	Corr.,	− .4
				H. D.,	+ 0′.9				
h,	81 24 30	Corr.,	+ 9′ 00″	G. M. T.,	$0^{h}.67$	G. M. T.,	13 14 40 26 .2	Eq. t., $13^{d}\ 14^{h}\ 40^{m}$,	0 26 .2
z,	8° 35′ 30″ S.			Corr.,	+ 0′.603			H. D.,	− $0^{s}.6$
d,	9 15 00 N.							Int.,	$0^{h}.7$
				Dec.,	9° 15′ N.				
L,	0 39 30 N.							Corr.,	− $0^{s}.42$

Example: At sea, May 15, 1916, in Long. 0°, the observed meridian altitude of the sun's lower limb was 30° 13′ 10″; sun bearing north; I. C., +1′ 30″; height of the eye, 15 feet.

Obs. alt.,	30° 13′ 10″	(Tab. 46),	+10′ 32″	Dec., $14^{d}\ 22^{h}$,	18° 50′.2 N.	G. A. T.,	$0^{h}\ 00^{m}\ 00^{s}$
Corr.,	+ 12 02	I. C.,	+ 1 30			Eq. t.,	− 3 47 .5
				H. D.,	+ 0′.6		
h,	30 25 12	Corr.,	+12 02	G. M. T.,	$1^{h}.94$	G. M. T.,	$14^{d}\ 23^{h}\ 56^{m}\ 12^{s}.5$
z,	59° 34′ 48″ S.			Corr.,	+ 1′.16		
d,	18 51 24 N.						
				Dec.,	18° 51′.4 N.		
L,	40 43 24 S.						

Example: January 1, 1916, the observed meridian altitude of Sirius was 53° 23′ 40″, bearing south; I. C.,+5′ 0″; height of the eye, 17 feet.

Obs. alt.,	53° 23′ 40″	(Tab. 46)	−4′ 45″	Dec. ✳,	16° 36′ 00″ S.
Corr.,	+ 15	I. C.	+5 00		
h,	53 23 55	Corr.	+0′ 15″		
z,	36° 36′ 05″ N.				
d,	16 36 00 S.				
L,	20 00 05 N.				

Example: June 13, 1916, in Long. 65° W., and in a high northern latitude, the meridian altitude of the sun's lower limb was 8° 16′ 10″ below the pole; height of the eye, 20 feet; I. C., 0′ 00″.

Greenwich apparent time of lower culmination, June 13, $16^h\ 20^m$ (=Long.+12^h).

Obs. alt.,	8° 16′ 10″	(Tab. 46),	+ 5′ 11″	G. A. T.,	$16^h\ 20^m\ 00^s$
Corr.,	5 11			Eq. t.,	− 04.3
h,	8 21 21	Dec. 16^h,	23° 15.′1 N.	G. M. T.,	$16^h\ 19^m\ 55^s.7$
z,	81° 38′ 39″ S.	H. D.,	+ 0″.1		
180°−*d*,	156 44 52 N.	G. M. T.,	$0^h.33$		
L,	75 06 13 N.	Corr.,	+ 0″.03		
Alternative method.		Dec.,	23° 15′ 08″ N.		
h,	8° 21′ 21″	*p*,	66° 44′ 52″		
p,	66 44 52	180°−*d*,	156° 44′ 52″ N.		
L,	75 06 13 N.				

Example: July 10, 1916, in Long. 80° W., the observed meridian altitude of the moon's upper limb was 59° 6′ 40″, bearing north; I. C., +2′ 0″; height of the eye, 19 feet.

Obs. alt.,	59° 06′ 40″	(Tab. 49),	+ 9′ 30″	G. M. T., of Gr. transit	$7^h\ 40^m$
Corr.,	+ 11 30	I. C.,	+ 2 00	Corr. for Long. (Tab. 11),	+ 13
h,	59 18 10	Corr.,	+ 11′ 30″	L. M. T. local transit,	7 53
z,	30 41 50 S.	Hor. Par.,	59′ 12″	Long.,	+ 5 20
d,	22 40 42 S.			G. M. T., local transit,	$13^h\ 13^m$
L,	53 22 32 S.	Dec. 12^h,	22° 30′.4 S.	H. D.,	− 8.′5
		Corr.,	− 10 .3	G. M. T.,	$1^h.22$
		Dec.,	22° 40′.7 S.	Corr.,	− 10′.3

Example: At sea, September 16, 1916, in Long. 75° E., the observed meridian altitude of Jupiter was 51° 25′ 24″, bearing north; I. C.,+3′ 0″; height of the eye, 16 feet.

Obs. alt.,	51° 25′ 24″	(Tab. 46),	− 4′ 42″	G. M. T., Gr. transit,	$14^h\ 28^m$
Corr.,	− 1 42	I. C.,	+ 3 00	Corr. for Long.,	+ 1
h,	51 23 42	Corr.,	− 1′ 42″	L. M. T., of local transit,	14 29
z,	38 36 18 S.			Long.,	− 5 00
d,	11 38 54 N.			G. M. T. of local transit,	9 29
L,	26 57 24 S.	Dec. 0^h,	11° 39′.5 N.	H. D.,	− 4″
		Corr.,	− .6	G. M. T.,	$9^h.48$
		Dec.,	11° 38′.9 N.	Corr.,	−37″=.6′

325. Constant.—In working a meridian altitude, especially the daily noon observation of the sun, it is frequently a convenience to arrange the terms so that all computation, excepting the application of the observed altitude, is completed beforehand; then the ship's latitude will be known immediately after the sight has been taken, it being necessary only to add or subtract the altitude. (See art. 323.)

It is assumed that the noon longitude will be sufficiently accurately known in advance to enable the navigator to correct the declination; also the approximate meridian altitude to correct the parallax and refraction; if the latter is not known, it may readily be found from the declination and approximate latitude.

Generally speaking,

$$
\begin{aligned}
\text{Lat.} &= \text{Zenith distance} + \text{Dec.},\\
&= 90^\circ - \text{True alt.} + \text{Dec.},\\
&= 90^\circ - (\text{Obs. alt.} + \text{Corr.}) + \text{Dec.},\\
&= (90^\circ + \text{Dec.} - \text{Corr.}) - \text{Obs. alt.},
\end{aligned}
$$

in which the quantity (90° + Dec. − Corr.) may be termed a *Constant* for the meridian altitude of the day, as it remains the same regardless of what the observed altitude may prove to be. The constant having been worked up before the observation is made, the latitude will be known as soon as the observed altitude is applied.

To avoid the confusion that might arise from the necessity of combining the terms *algebraically* according to their different names, it may be convenient to divide the problem into four cases and lay down rules for the *arithmetical* combination of the terms, disregarding their respective names as follows:

Case I. Lat. and Dec. same name, Lat. greater, +90° + Dec. − Corr. − Obs. alt.
Case II. Lat. and Dec. same name, Dec. greater, −90° + Dec. + Corr. + Obs. alt.
Case III. Lat. and Dec. opposite names, +90° − Dec. − Corr. − Obs. alt.
Case IV. Lat. and Dec. same name, lower transit, +90° − Dec. + Corr. + Obs. alt.

The correctness of such an arrangement will become readily apparent from an inspection of figure 50. The assumption has been made that the correction to the observed altitude is positive; when this is not true the sign of the correction must be reversed.

As examples of this method, the first, second, third, and fifth of the examples previously given illustrating the meridian altitude will be worked, using the constant; the details by which Corr. and Dec. are obtained are omitted, being the same as in the originals.

	1st Example. *Case I.*	2d Example. *Case II.*	3d Example. *Case III.*	5th Example. *Case IV.*
	+90° 00′ 00″	−90° 00′ 00″	+90° 00′ 00″	+90° 00′ 00″
Dec.,	+23 27 06	+9 15 00	−18 51 24	−23 15 08
Corr.,	− 13 21	+ 9 00	− 12 02	+ 5 11
Constant,	+113 13 45	−80 36 00	+70 56 34	+66 50 03
Obs. alt.,	−40 04 00	+81 15 30	−30 13 10	+8 16 10
Lat.,	73 09 45 (N.)	0 39 30 (N.)	40 43 24 (S.)	75 06 13 (N.)

BY REDUCTION TO THE MERIDIAN.

326. Should the meridian observation be lost, owing to clouds or for other reason, altitudes may be taken near the meridian and the times noted by a watch compared with the chronometer, from which, knowing the longitude, the hour angle may be deduced.

If the observations are within 26^m from the meridian, before or after, the correction to be applied to the observed altitude to reduce it to the meridian altitude may be found by inspection of Tables 26 and 27. Table 26 contains the variation of the altitude for one minute from the meridian, expressed in seconds and tenths of a second. Table 27 contains the product obtained by multiplying the square of the minutes and seconds by the change of altitude in one minute.

Let a = change of altitude (in seconds of arc) in one minute from the meridian:
H = meridian altitude;
h = corrected altitude at observation; and
t = interval from meridian passage.

The value of the reduction to the meridian altitude of each altitude is found by the formula:

$$H = h + at^2,$$

a being found in Table 26, and at^2 in Table 27; hence the following rule:

Find the hour angle of the body in minutes and seconds of time. Take from Table 26 the value of a corresponding to the declination and the latitude. Take from Table 27 the value of at^2 corresponding to the a thus found and to the interval, in minutes and seconds, from meridian passage. This quantity will represent the amount necessary to reduce the corrected altitude at the time of observation to the corrected altitude at the meridian passage; it is always additive when the body is near upper transit, and always to be subtracted when near lower transit.

If the mean of a number of sights is to be taken, determine each reduction separately, take the mean of all the reductions, and apply it to the mean of the altitudes;

it is incorrect, in such a case, to take the mean of the times and work the sight with this single value of t. The differences of altitude being small, the parallax and refraction will be sensibly the same for all, and one computation of the correction to the observed altitude will suffice.

Knowing the meridian altitude, the latitude is to be found as previously explained.

327. When several sights are taken, the most expeditious method of calculating will be to find first the watch time of transit, and thence obtain the hour angle of each observation by comparing the watch time of observation. The watch time of transit may be found as already explained (art. 323) for computing that quantity as a guide in taking the meridian altitude, but the hour angle thus obtained is subject to a correction. The difference between watch time of transit and watch time of observation gives the watch time—that is, the mean time—elapsing between transit and observation. A fixed star covers in that time an angle corresponding to the sidereal and not to the mean time interval, and a reduction should be made accordingly to give its true hour angle at the instant of observation. A planet's hour angle should be corrected in the same way (for we may disregard its very small change in right ascension). The correction may be entirely neglected in the case of the sun, as the difference between mean and apparent time intervals is immaterial. The reduction of the hour angle in the case of the moon becomes rather cumbersome, so much so that it is better to find the hour angle of this body by the more usual method of converting watch time to G. M. T., and thence to L. S. T., and finding the difference between the latter and the R. A.; an additional reason for this is that the G. M. T. of observation must be known exactly, with the moon, for the correction of the declination (art. 330).

328. Table 26 includes values of the latitude up to 60°, and those of the declination up to 63°, thus taking in all frequented waters of the globe and all heavenly bodies that the navigator is likely to employ. No values of a are given when the altitudes are above 86° or below 6°, as the method of reduction to the meridian is not accurate when the body transits very near the zenith, and the altitudes themselves are questionable when very low. In case it is desired to find the change of altitude in one minute from noon for conditions not given in the tables, it may be computed by the formula:

$$a=\frac{1''.9635 \cos L \cos d}{\sin (L-d)}.$$

In working sights by this method where great accuracy is required, as in determining latitudes on shore for surveying purposes, it is well to compute the a rather than to take it from the table, as one is thus enabled to employ the value as found to the second decimal place.

Due regard must be paid to the names of the declination and latitude in working this formula; if they are of opposite names, the declination is negative, and L and d should be added together to obtain $L-d$.

329. Table 27 contains values of at^2 up to the limits within which the method is considered to apply with a fair degree of accuracy. It must not be understood that the plan of reduction to the meridian is not available for wider limits, but it would seem preferable to employ the ϕ' ϕ'' formula, described hereafter, when the hour angle falls beyond that for which the table is computed. On the other hand, the reduction is not exact in all cases covered by the table; while sufficiently so for sea navigation, the limits given are far too wide for the precise determinations required in surveying, where the aim should be to observe bodies under such conditions that the total reduction at^2 shall not exceed 1′.

330. It should be kept clearly in mind when employing the method of reduction to the meridian that the resulting latitude is that of the ship at the instant of observation, and to bring it up to noon the run must be applied. The declination should properly be corrected for the instant of observation; with the sun or a planet, it is sufficiently accurate to use the declination at meridian passage, unless the interval from the meridian be quite large; but the moon's declination changes so rapidly that the exact time of observation must be used in its correction when working with this body.

Example: In latitude 47° S., having previously worked up the constant for meridian altitude, 78° 42′ 10″, observed altitude of sun near meridian, 31° 11′ 50″; Dec. 11° N.; watch time, $11^h\ 40^m\ 21^s$, watch fast of L. A. T., 7^s. Find the latitude.

Watch time,	$11^h\ 40^m\ 21^s$	Obs. alt.,	31° 11′ 50″	*a* (Tab. 26),	1″.6
Watch fast,	07	at^2,	+ 10 24		
L. A. T.,	11 40 14	Mer. alt.,	31 22 14	at^2 (Tab. 27),	1″.0 = 6′ 30″
		Constant,	78 42 10		.6 = 3 54
t,	$19^m\ 46^s$				1 .6 = 10 24
		Lat.,	47 19 56 S.		

Example: At sea, July 12, 1916, in Lat. 50° N., Long. 40° W., observed circum-meridian altitude of the sun's lower limb, 61° 48′ 30″, the time by a chronometer regulated to Greenwich mean time being $2^h\ 41^m\ 39^s$; chro. corr., $-2^m\ 30^s$ I. C., −3′ 0″; height of the eye, 15 feet. Find the latitude.

Chro. t.,	$2^h\ 41^m\ 39^s$	⊙	61° 48′ 30″	Dec. 2^h,	21° 58′.9 N.	Eq. t. 2^h.,	$5^m\ 24^s.1$
C. C.,	− 2 30	Corr.,	+ 8 31	H. D.,	− 0′.4	H. D.,	+ $0^s.3$
G. M. T.,	2 39 09	*h*,	61 57 01	G. M. T.,	$0^h.65$	G. M. T.,	$0^h.65$
Eq. t.,	− 5 24.3	(Tab. 46),	+ 11′ 31″	Corr.,	− 0′.26	Corr.,	+ $0^s.195$
G. A. T.,	2 33 44.7	I. C.,	− 3 00	Dec.,	21° 58′ 38″N.	Eq. t.,	$5^m\ 24^s.3$
Long.,	− 2 40 00.0	Corr.,	+ 8′ 31″				(*Subtract* from *mean* time.)
L. A. T.,	11 53 44.7						
t,	6 15.3						

h,	61° 57′ 01″		*a* (Tab. 26),	2″.5	
at^2,	+ 1 38		at^2 (Tab. 27),	2″.0 = 1′ 18″	
H,	61 58 39			0 .5 = 0 20	
z,	28 01 21	N.		2 .5 = 1 38	
d,	21 58 38	N.			
L,	49 59 59	N.			

Example: May 31, 1916, in Lat. 30° 15′ N., Long. $5^h\ 25^m\ 42^s$ W., about 9 p. m., observed with a sextant and artificial horizon a series of altitudes of Spica; mean observed double altitude 98° 06′ 34″; noted times as enumerated below by a watch compared with a chronometer which was $2^m\ 33^s$ fast of G. M. T.; C−W, $5^h\ 29^m\ 40^s$; I. C., −3′ 00″. Find the latitude.

R. A. ✳ (L. S. T. transit),	$13^h\ 20^m\ 48^s.9$	Mean 2 alt. ✳,	98° 06′ 34″	R. A. ✳,	$13^h\ 20^m\ 48^s.9$
Long.,	+ 5 25 42	I. C.,	− 3 00	Dec.,	10° 43′ 42″ S.
G. S. T.,	18 46 30.9		2) 98 03 34	*a* (Tab. 26),	2″.5
R. A. M. S. Gr. 0^h,	4 34 36.1		49 01 47		
Sid. int. from 0^h,	14 11 54.8	ref.,	− 50		
Red. (Tab. 8),	− 2 19.7	*h*,	49 00 57		
G. M. T.,	14 09 35.1				
C. C. (sign reversed),	+ 2 33				
Chro. time transit,	14 12 08.1				
C−W,	− 5 29 40				
Watch time transit,	8 42 28				

Watch times.	Intervals from transit. Mean time.	Intervals from transit. Sid. time.	at^2 (Tab. 27). 2.0	at^2 (Tab. 27). 0.5	at^2 (Tab. 27). 2.5
$8^h\ 33^m\ 05^s.0$	$-\ 9^m\ 23^s.0$	$-\ 9^m\ 24^s$	2′ 56″	0′ 44″	3′ 40″
35 06.5	7 21.5	7 23	1 49	0 27	2 16
37 54.0	4 34.0	4 35	0 42	0 10	0 52
40 37.0	1 51.0	1 51	0 07	0 02	0 09
42 54.5	+ 0 26.5	+ 0 27	0 00	0 00	0 00
45 32.5	3 04.5	3 05	0 19	0 04	0 23
47 33.0	5 05.0	5 06	0 52	0 13	1 05
49 20.0	6 52.0	6 53	1 35	0 23	1 58
52 59.5	10 31.5	10 33	3 42	0 55	4 37
					9) 15 00
					1 40

h,	49° 00′ 57″	
at^2,	+ 1 40	
H,	49 02 37	
z,	40 57 23	N.
d,	10 43 42	S.
L,	30 13 41	N.

Example: August 6, 1916, Lat. 59° S., Long. 175° 27′ E., during evening twilight, observed an altitude of Achernar, near lower transit, 26° 52′; watch time, $4^h\ 31^m\ 12^s$; C—W, $0^h\ 18^m\ 07^s$; chro. fast of G. M. T., $12^m\ 42^s$; I. C., +1′ 20″; height of eye, 24 ft. Find hour angle by both methods; thence the latitude.

R. A. ✱ + 12^h L. S. T. lower trans.		13^h	34^m	$38^s.4$
Long.,	−	11	41	48
G. S. T.,		1	52	50 .4
R. A. M. S. Gr. $5^d\ 0^h$,	−	8	54	48 .9
Sid. int.,		16	58	01 .5
Red. (Tab. 8),	−		2	46 .8
G. M. T.,		16	55	14 .7
C. C. (sign reversed),	+		12	42
Chro. time,		5	07	56 .7
C−W,	−	0	18	07
Watch time transit,		4	49	49 .7
Watch time obs.,		4	31	12
t {Mean time,			18	37 .7
t {Sid. time,			18	40 .8

Watch time,		4^h	31^m	12^s
C—W,	+	0	18	07
Chro. t.,		4	49	19
C. C.,	−		12	42
G. M. T. 5^d		16	36	37
R. A. M. S. Gr. $5^d\ 0^h$,	+	8	54	48. 9
Red. (Tab. 9),	+		2	43. 7
G. S. T.,		1	34	09. 6
Long.,	+	11	41	48
L. S. T.,		13	15	57. 6
R. A. ✱ +12^h		13	34	38. 4
t,			18	40. 8

Obs. alt. ✱,		26°	52′	00″
Corr.,	−		5	23
h,		26°	46′	37″
at^2,	−		3	29
H,		26	43	08
p,		32	20	48
L,		59	03	56 S.

(Tab. 46),	−6′	43″
I. C.,	+1	20
Corr.,	5′	23″

R. A. ✱,	$1^h\ 34^m\ 38.^s4$
Dec.,	57° 39′ 12″ S.
p,	32° 20′ 48″
a (Tab. 26),	0″.6
at^2 (Tab. 27),	3′ 29″

331. Advantages are gained in working out *meridian altitudes* and *reductions to the meridian*, in finding the *constant* for a meridian altitude or a reduction to the meridian, and in predicting the approximate altitude of a body to be observed on or near the meridian, by projecting, in a quickly and roughly drawn diagram on the plane of the meridian of the observer, the known data entering into the problem. The diagram or figure will show at once how to combine the data to find the required result, and its use tends greatly to accuracy. It is only necessary to know the meaning of the terms already defined and to remember the single principle *that the latitude of a place is equal to the declination of its zenith.*

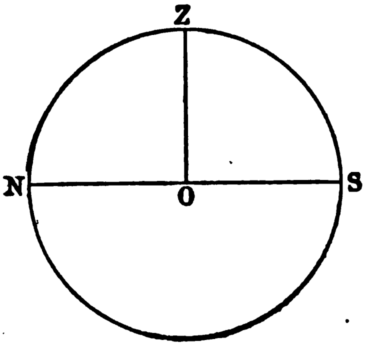

Fig. 51.

In every case draw a circle (a rough approximation will do) *to represent the plane of the meridian,* as in figure 51. The center O is the position of the observer. Draw a horizontal line through O, marking its intersection with the circumference on the right-hand side S, and on the left-hand side N. Erect a perpendicular to this line at O, and mark its intersection with the circumference Z. The line NS is the horizon; Z is the zenith. The arc ZS is that portion of the meridian between the zenith and the south point of the horizon; the arc ZN is that portion of the meridian between the zenith and the north point of the horizon. If the meridian altitude of a body is known (i. e., its altitude above the horizon on the meridian), and if it is known whether it bears to the southward or to the northward, its position can be projected at once on the figure. Having the position of the heavenly body on the meridian and knowing the declination of the body, it is evident where to draw in the projection of the equator. Having the projection of the equator, the angular distance between the equator and the zenith (i. e., the declination of the zenith) is the latitude.

Thus in figure 52, supposing the meridian altitude of any heavenly body, M, has been observed, and that at the time of observation it was bearing south; also that the declination, *d*, of the body was south. It is known that the true altitude, *h*, = observed altitude ± altitude corr. Since the body bears south, if the true altitude is *h*, the position of the body, M, can be located by laying off the arc SM = *h*, or by drawing OM so that the angle SOM = *h*. This gives the position of the heavenly body on the meridian. Since this body is south of the equator by the amount of the declination, the position of the equator may be drawn by laying off the angle MOQ = *d*. OQ is the projection of the equator, and the arc ZQ (or the angle ZOQ), being the *declination of the zenith*, is equal to the latitude. The formula for finding the latitude may be written by inspection of the figure:

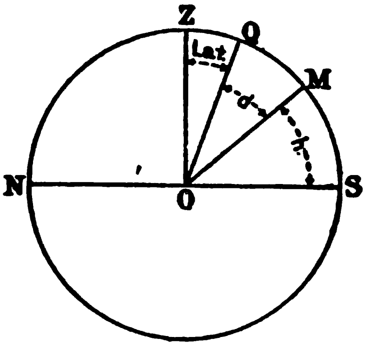

FIG. 52.

$$L = 90° - (h + d) = 90° - h - d. \qquad (1)$$

Since $h =$ obs. alt. ± corr.,

$$L = 90° - \text{obs. alt.} \pm \text{corr.} - d. \qquad (2)$$

By a similar process formulæ may be written for determining the *approximate altitude* of the heavenly body when on the meridian and for getting a noon *constant*. The former is necessary to get the altitude correction before taking the sight; the latter, so that the latitude may be obtained as soon as the altitude is read from the sextant. In these cases the D. R. latitude and longitude, which have to be worked out in advance for noon, are used. The longitude is used to get the correction to be applied to the equation of time to get the G. M. T. of local apparent noon in order to get the correct declination at Local Apparent Noon at the noon position. Knowing the approximate latitude and the declination, they are projected on the figure in this way. If the latitude is north, the zenith is to the northward of the equator by the amount of the latitude, and to get the position of the equator lay off the angle ZOQ = Lat. If the latitude were south, the equator would of course be on the north side of the zenith by the amount of the latitude, and OQ would be on the north side of the circle. Having the position of the equator, draw in the position of the heavenly body by laying it off to the north side or to the south side of the equator according to the amount and direction of its declination. The angle between the horizon and the heavenly body will be the altitude of the body. This is the usual method of plotting, and all that has to be done is to lay the angles off on the proper sides, marking them appropriately, and then write down the formulæ. Suppose it is required to find the approximate noon altitude. An inspection of the figure shows that

$$\text{approx. } h = 90° - (L + d) \text{ where L is the D. R. Lat.} \qquad (3)$$

Suppose it is required to find the constant (K) for a meridian altitude. It is seen from the figure that

$$L = 90° - h - d = 90° - \text{obs. alt.} \pm \text{corr.} - d$$
$$= K - \text{obs. alt.}$$

or

$$K = 90° \pm \text{corr.} - d. \qquad (4)$$

In the same way any combination may be plotted, and the correct formulæ may be written out at once. Suppose on a certain day it is found that at noon the position will be approximately Lat. 10° S., Long. 30° 15′ W., and that the declination of the sun at noon, corrected for G. M. T. of local apparent noon at the noon position, is 20° 30′ S., and it is desired to find the approximate noon altitude and obtain the constant, K. Draw the circle representing the plane of the meridian (see fig. 53), draw NS representing the horizon, and OZ representing the line to the zenith. Since the approximate latitude is 10° S, the equator must be 10° north of the zenith, and OQ is drawn to the north of Z so that the angle $ZOQ = 10°$. OQ is then the projection of the equator. The body being 20° 30′ south of the equator, lay off OM so that the angle $QOM = 20° 30'$. SOM will be the approximate altitude, and the formula for it is

$$\text{approx. } h = 90° + L - d, \qquad (5)$$

it is also seen that

$$L = h + d - 90° = \text{obs. alt.} \pm \text{corr.} + d - 90° = K + \text{obs. alt.}$$

or

$$K = \pm \text{corr.} + d - 90°.$$

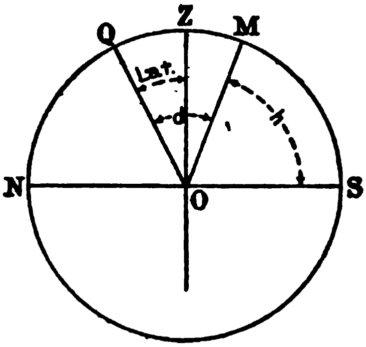

Fig. 53.

If, instead of the formulæ for a meridian altitude, the formulæ for a reduction to the meridian are required, there is no change in the figure or the method. The altitude observed before or after noon is corrected to make it the noon altitude by the formula $h = h' + at^2$, where h is the noon altitude, h' the altitude observed t minutes before or after noon, and a the rate of change of altitude near noon. So that in the case shown in figure 53

$$L = h + d - 90° = h' + at^2 + d - 90° = \text{obs. alt.} \pm \text{corr.} + at^2 + d - 90° = K + \text{obs. alt.} \qquad (6)$$

or

$$K = \pm \text{corr.} + at^2 + d - 90°.$$

The formula for the approximate value of h, as shown in (5), is used for getting the altitude correction in this case, as the slight difference in altitude makes no change in the correction.

The formula for latitude, given in equation (6), is the formula for the latitude at noon at the point where the observation was taken. But a ship steaming on a course does not remain at that point, and what is desired is the correct latitude of the ship's position at noon. If L′ represents the latitude of the place where the observation was taken, and L the latitude of the place where the ship is at noon, then $L = L' \pm \Delta L$, where ΔL is the change in latitude from the time of observation until noon. This is taken from the Traverse Tables. But from equation (6) it is seen that $L' = \text{obs. alt.} \pm \text{corr.} + at^2 + d - 90°$

$$\therefore L = L' \pm \Delta L = \text{obs. alt.} \pm \text{corr.} + at^2 + d - 90° \pm \Delta L.$$
$$= K + \text{obs. alt.}$$

or

$$K = \pm \text{corr.} + at^2 + d - 90° \pm \Delta L.$$

BY A SINGLE ALTITUDE AT A GIVEN TIME.

332. This observation should be limited to conditions where the body is within three hours of meridian passage and where it is not more than 45° from the meridian in azimuth; also where the declination is at least 3°. On the prime vertical the solution by this method is inexact, and when the hour angle is 6^h, or the declination 0°, it is impracticable.

The problem is: Given the hour angle, declination, and altitude; to find the latitude. The solution is accomplished by letting fall, in the usual astronomical triangle, a perpendicular from the body to the meridian, and considering separately the distances on the meridian, from the pole and zenith, respectively, to the point of intersection of the perpendicular; the sum or difference of these distances is the co-latitude.

Following the usual designation of terms and introducing the auxiliaries ϕ' and ϕ'', the formulæ are as follows:

$$\tan \phi'' = \tan d \sec t;$$
$$\cos \phi' = \sin h \sin \phi'' \operatorname{cosec} d;$$
$$L = \phi' + \phi''.$$

The terms ϕ' and ϕ'' will have different directions of application according to the position of the body relative to the observer. From a knowledge of the approximate latitude, the method of combining them will usually be apparent; it is better, however, to have a definite plan for so doing, and this may be based upon the following rule:

Mark ϕ'' north or south, according to the name of the declination; mark ϕ' north or south, according to the name of the zenith distance, it being *north* if the body bears south and east or south and west, and *south* if the body bears north and east or north and west. Then combine ϕ'' and ϕ' according to their names; the result will be the latitude, except in the case of bodies near lower transit, when $180° - \phi''$ must be substituted for ϕ'' to obtain the latitude.

It may readily be noted that if we substitute ϕ'' for declination and ϕ' for zenith distance, the problem takes the form of a meridian altitude; indeed, the method resolves itself into the finding of the zenith distance and declination of that point on the meridian at which the latter is intersected by a perpendicular let fall from the observed body.

The time should be noted at the instant of observation, from which is found the local time, and thence the hour angle of the celestial object.

If the sun is observed, the hour angle is the L. A. T. in the case of a p. m. sight, or 12^h − L. A. T. for an a. m. sight. If any other body, the hour angle may be found as hitherto explained.

Example: June 7, 1916, in Lat. 30° 25′ N., Long. 81° 25′ 30″ W., by account; chro. time, $6^h\ 22^m\ 52^s$; obs. ☉ 75° 13′, bearing south and west; I. C., −3′ 00″; height of the eye, 25 feet; chro. corr. $-2^m\ 36^s$. Find the latitude.

Chro. t.,		$6^h\ 22^m\ 52^s$	Obs. alt. ☉,		75° 13′ 00″	Eq. t., 6^h,		$1^m\ 20^s.4$	Dec., 6^h,		22° 46′.6 N.
C. C.,	−	2 36	Corr.,	+	7 39	Corr.,	−	.2	Corr.,	+	.07
G.M.T.,		6 20 16	h,		75 20 39	Eq. t.,		1 20.2	Dec.,		22° 46′ 40″ N.
Eq. t.,	+	1 20									
G.A.T.,		6 21 36	(Tab. 46),	+	10′ 39″	H. D.,	−	$0^s.5$	H. D.,	+	0′.2
Long.,	−	5 25 42	I. C.,	−	3 00	G. M. T.,		$0^h.3$	G. M. T.,		$0^h.33$
L. A. T. = t,		$0^h\ 55^m\ 54^s$ W. 13° 58′ 30″	Corr.,	+	7′ 39″	Corr., (*Add* to *mean* time.)	−	$0^s.15$	Corr.,		0′.066

t,	13° 58′ 30″		sec	.01305		
d,	22 46 40		tan	9.62315	cosec	.41211
h,	75 20 39				sin	9.98563
ϕ'',	23 23 55	N.	tan	9.63620	sin	9.59893
ϕ',	7 05 00	N.			cos	9.99667
Lat.,	30 28 55	N.				

Example: October 10, 1916, p. m., in Lat. 6° 20′ S. by account, Long. 30° 21′ 30″ W.; chro. time, $12^h\ 45^m\ 10^s$; observed altitude of moon's upper limb, 70° 15′ 30″, bearing north and east; I. C., −3′ 00″; height of eye, 26 feet; chro. fast of G. M. T., $1^m\ 37^s.5$. Required the latitude.

Chro. t.,		$12^h\ 45^m\ 10^s$	Obs. alt. ☾,		70° 15′ 30″	R. A. ☾ (12^h),		$0^h\ 42^m\ 16^s$	Dec. (12^h),		9° 52′.9 N.
C. C.,	−	1 37.5	Corr.,	−	4 27	Corr.,	+	1 32	Corr.,	+	10.1
G.M.T.,		12 43 32.5	h,		70 11 03	R. A.,		$0^h\ 43^m\ 48^s$	Dec.,		10° 03′ N.
R. A. M. S.,	+	13 15 01.4									
Red. (Tab. 9),	+	2 05.4	(Tab. 49),	−	1′ 27″	H. D.,	+	$128^s.5$	H. D.,	+	14′.05
G. S. T.,		2 00 39.3	I. C.,	−	3′ 00″	G. M. T.,		$0^h.72$	G. M. T.,		$0^h.72$
R. A. ☾,	−	0 43 48.0	Corr.,	−	4′ 27″	Corr.,	+	92″.5	Corr.,	+	10′.11
H. A. from Gr.,		1 16 51.3 W.									
Long.,		2 01 26.0 W.									
t,		$0^h\ 44^m\ 34^s.7$ E. 11° 08′ 40″.5							Hor. Par.,		58′ 18″

t,	11° 08′ 40″		sec	.00627			
d,	10 03 00		tan	9.24853		cosec	.75819
h,	70 11 03					sin	9.97349
ϕ'',	10 14 21	N.	tan	9.25680		sin	9.24983
ϕ',	16 36 00	S.				cos	9.98151
Lat.	6 21 39	S.					

Example: August 6, 1916, p. m., in Lat. 52° 59′ S. by D. R., Long. 146° 32′ E., observed altitude of Achernar, near lower transit, 24° 01′ 20″ bearing south and east; watch time, $6^h\ 48^m\ 22^s$; C—W, $2^h\ 13^m\ 33^s$; chro. corr. on G. M. T., + $1^m\ 57^s$; height of eye, 18 feet; I. C. +1′ 00″. Find the latitude.

Watch time,		6^h	48^m	22^s	
C—W,	+	2	13	33	
Chro. t.,		9	01	55	
C. C.,	+		1	57	
G. M. T. 5^d,		21	03	52	
R. A. M. S.,	+	8	54	48.9	
Red. (Tab. 9),	+		3	27.6	
G. S. T.,		6	02	08.5	
R. A. ✳,		1	34	38.4	
H. A. from Gr.,		4	27	30.1	W.
Long.,		9	46	08	E.
H. A.,		14	13	38	W.
		9	46	22	E.

$\begin{cases} 2^h\ 13^m\ 38^s \\ 33^\circ\ 24'\ 30'' \end{cases}$

Obs. alt. ✳,		24°	01′	20″
Corr.,	−		5	19
h,		23	56	01
(Tab. 46),	−		6′	19″
I. C.,	+		1	00
Corr.,	−		5′	19″

R. A. ✳, $1^h\ 34^m\ 38^s.4$

Dec., 57° 39′ 12″ S.

t,	33 24 30		sec.	.07843		
d,	57 39 12		tan.	.19838	cosec.	.07323
h,	23 56 01				sin.	9.60818
$180^\circ - \phi''$,	117 51 52	S.	tan.	.27681	sin.	9.94648
ϕ',	64 52 49	N.			cos.	9.62789
Lat.,	52 59 03	S.				

BY THE POLE STAR.

333. This method, confined to northern latitudes, is available when the star Polaris and the horizon are distinctly visible, the time of the observation being noted at the moment the altitude is measured.

Reduce the observed altitude of Polaris to the true altitude.

Reduce the recorded time of observation to the local sidereal time.

If the sidereal time is
- less than 1h 29.2m, subtract it from 1h 29.2m;
- between 1h 29.2m and 13h 29.2m, subtract 1h 29.2m from it;
- greater than 13h 29.2m, subtract it from 25h 29.2m;

and the remainder is the hour-angle of Polaris.

With this hour-angle take out the correction from Table I of the Nautical Almanac, and add it to or subtract it from the true altitude, according to its sign. The result is the approximate latitude of the place.

Example: 1916, August 5, at $10^h\ 40^m\ 30^s$ p. m. local mean solar time, in longitude 59° west of Greenwich, suppose the true altitude of Polaris to be 33° 20′ 0″, required the latitude of the place.

Local astronomical mean time		10^h	40^m	30^s
Reduction from Table 9 for $10^h\ 40^m\ 30^s$	+		01	45
Greenwich sidereal time of mean noon, August 5		8	54	49
Reduction from Table 9 for longitude (=$3^h\ 56^m$ west, or plus)	+		00	39
Sum (having regard to signs) is equal to local sidereal time		19	37	43
		25^h	29^m	12^s
Subtract sidereal time		19	37	43
Remainder is equal to hour angle of Polaris		5	51	29

True altitude	+33° 20′ 00″
Correction from Table I of the Nautical Almanac	− 1 51
Approximate latitude of the place	+33 18 09

Observations of Polaris for latitude should be made when practicable near the times of upper or of lower culminations (hour angle 0^h or 12^h). However, at sea, if made near elongation (hour angle 6^h or 18^h), the hour angle, and hence the local time, should be known within one minute.

334. The latitude may be approximately found from an altitude of Polaris by computation from the formula:

$$L = h \pm p \cos t,$$

in which,

h = true altitude, deduced from the observed altitude;

p = polar distance = $90° - d$, the apparent declination being taken from the Nautical Almanac for the time of observation.

t = star's hour angle.

Reduce the recorded time of observation to the local sidereal time.

Take out, from the Nautical Almanac, the apparent right ascension of Polaris for the time of observation.

Subtract the apparent right ascension from the local sidereal time, and the remainder will be the hour angle.

To the log cosine of the hour angle add the logarithm of the polar distance in minutes; the number corresponding to the resulting logarithm will be a correction in minutes to be subtracted from the star's true altitude to find the latitude when the hour angle is less than 6^h or more than 18^h, and to be added to the star's true altitude to find the latitude when the hour angle is more than 6^h and less than 18^h.

Example: June 11, 1916, from an observed altitude of Polaris, the true altitude was found to be 29° 5′ 55″. The time noted by a Greenwich chronometer was $13^h\ 41^m\ 26^s$; chro. corr. $-2^m\ 22^s$; Long. $5^h\ 25^m\ 42^s$ W.

Chro. time,		$13^h\ 41^m\ 26^s$
C. C.,	−	2 22
G. M. T., 11^d,		13 39 04
R. A. M. S.,	+	5 17 58.2
Red. (Tab. 9),	+	2 14.5
G. S. T.,		18 59 17
R. A. ✱,	−	1 29 19
H. A. from Gr.,		17 29 58 W.
Long.,		5 25 42 W.
H. A.,		12 04 16 W.
t,		$11^h\ 55^m\ 44^s$ E. 178° 56′ 00″

h,		29° 05′ 55″
$p \cos t$,	+	1 08 36
Lat.,		30 14 31 N.

R. A. ✱,			$1^h\ 29^m\ 19^s$
Dec.,			88° 51′ 24″ N.
p,			1° 08′ 36″ 68′.6
p,	68′.6	log	1.83632
t,	178° 56′	cos (−)	9.99992
$p \cos t$, −	68′.6 1° 08′ 36″	log (−)	1.83624

If the computation is extended according to the following formula, inserting the value of p in seconds of arc:

$$L = h \pm p \cos t + \tfrac{1}{2} p^2 \sin 1'' \sin^2 t \tan h,$$

the resulting latitude is subject to no greater error than 1″; but if $p \cos t$ is the only correction applied to the altitude of Polaris, as in the above example, the resulting latitude, while subject to little error when Polaris is observed near the meridian, will have an error, when $t = 6$ hours, increasing with the altitude and amounting to 1′ when $h = 54°$ and to 3′ when $h = 68° 30′$.

DETERMINATION ON SHORE.

335. In finding the latitude on shore all the methods are available that have been heretofore explained for employment in finding the latitude at sea, provided only that an artificial horizon (art. 256) be supplied to take the place of the natural horizon of the sea in obtaining a measurement, by the sextant, of the altitude of the celestial body. In addition, other methods may be conveniently employed, involving the use of a theodolite or an altazimuth instrument, which the observer at sea is precluded from using because the employment of such instruments requires a steady platform.

If the observation is to be made with a theodolite or altazimuth, the instrument must first be placed level so that the line of collimation of the telescope revolves in the plane of the true meridian. This may be accomplished by means of laying off a true meridian from the true bearing of a terrestrial object from the instrument, as determined by the observation described in articles 360 and 361.

The altitude of the celestial body is then measured by bringing the horizontal cross wire of the telescope on the body at the instant the body transits the meridian or crosses the vertical cross wire of the telescope, and then reading the vertical circle.

The latitude is then deduced from the formula, $L = d + z$, after applying the proper corrections for index error, parallax, and refraction. The correction for index error is obtained by bringing the telescope to a horizontal position, as indicated by the level tube attached to the telescope, and taking the corresponding reading of the vertical circle immediately before and after each observation.

By observing the altitude of each of two stars with approximately the same zenith distance, one north of the zenith and one south of the zenith, a mean value for latitude resulting from the two observations may be obtained which is not affected by the error in estimating the absolute value of the astronomical refraction, but simply by the error in estimating a very small difference of refraction of two stars at nearly the same altitude.

This method of determining the latitude of a station is known as the Horrebow-Talcott method, and consists of the measurement of the small differences of zenith distance of two stars which transit at about the same time on opposite sides of the zenith. The effect of this procedure is the attainment of greater precision due to the increased accuracy of a differential measurement over the corresponding absolute measurement, the elimination of the use of a graduated circle in the measurement, and the fact that the computed result is not affected by the error in estimating the absolute value of the astronomical refraction, but simply by the error in estimating a very small difference of refraction of two stars at nearly the same altitude.

After measuring the difference of meridional zenith distances of two stars which transit at about the same time on opposite sides of the zenith and with nearly the same zenith distances, the latitude may be deduced from the following formula:

Let d = declination of star south of zenith.
d' = declination of star north of zenith.
z = zenith distance of star south of zenith.
z' = zenith distance of star north of zenith.

$$\begin{aligned} \text{Then } L &= d + z \\ L &= d' - z' \\ \hline 2L &= d + d' + z - z' \\ L &= \tfrac{1}{2}(d + d') + \tfrac{1}{2}(z - z'); \end{aligned}$$

that is, the latitude is equal to one-half the sum of the declinations plus one-half the difference of zenith distances. The form of instrument used in measuring the differences of zenith distances is known as a zenith telescope, and consists of a telescope mounted on a horizontal axis supported by an upright or uprights in such a manner that it can be revolved about a vertical axis. A vertical circle is attached to the telescope for use in setting the telescope at the proper inclination with the horizontal to bring a particular star into the field of the telescope. A level tube is also attached to the telescope for use in bringing the telescope to the same inclination when observing on each of a pair of stars. The eyepiece of the telescope is fitted with a micrometer screw which operates a movable horizontal cross wire with which the bisections of the image of the observed body are made.

The process of observing for difference of zenith distances is as follows: If the first star of the pair of stars to be observed has a $\left\{\begin{matrix}\text{north}\\ \text{south}\end{matrix}\right\}$ zenith distance the telescope is revolved about its vertical axis until it points $\left\{\begin{matrix}\text{north}\\ \text{south}\end{matrix}\right\}$ in the plane of the meridian.

The approximate mean zenith distance of the two stars is then set off on the vertical circle, and the level bubble brought to the center of the tube. When the star appears in the field of the telescope the horizontal cross wire is brought to bisect the star and such bisection retained until the star crosses the vertical cross wire of the telescope. The micrometer head is then read. The telescope is then revolved through 180° about its vertical axis and brought to the same inclination with the horizontal by moving the telescope itself about its horizontal axis until the level bubble is at the center of the tube. In like manner the second star is bisected by the horizontal cross wire and the micrometer head again read. The difference between the two micrometer readings gives the difference of zenith distances of the two stars in terms of divisions of the micrometer, which when multiplied by the known angular value of one division of the micrometer gives the angular difference of the zenith distances of the two stars.

CHAPTER XIII.

LONGITUDE.

336. The *longitude* of a position on the earth's surface is measured by the arc of the equator intercepted between the *prime meridian* and the meridian passing through the place, or by the angle at the pole between those two meridians.

Meridians are great circles of the terrestrial sphere passing through the poles.

The *prime meridian* is that one assumed as the origin, passing through the location of some principal observatory, such as Greenwich, Paris, or Washington. That of Greenwich is the prime meridian not only for English and American navigators, but for those of many other nations.

Secondary meridians are those connected with the primary meridian, directly or indirectly, by exchange of telegraphic time signals.

Tertiary meridians are those connected with secondaries by carrying time in the most careful manner with all possible corrections.

Longitude is found by taking the difference between the hour angle of a celestial body from the prime meridian and its hour angle, at the same instant, from the local meridian. In determinations ashore the hour angle from the prime meridian may be found either from chronometers or from telegraphic signals; the local hour angle may be found by transit instrument or by sextant. In determinations at sea the chronometer and sextant give the only means available.

DETERMINATION ON SHORE.

337. TELEGRAPHIC DETERMINATION OF SECONDARY MERIDIANS.—In order to locate with accuracy the positions of prominent points on the coasts, it is necessary to refer them, by chronometric measurements, to secondary meridians of longitude which have been determined with the utmost degree of care.

Before the establishment of telegraphic cables, this was attempted principally through the observation of moon culminations, which seemed always to carry with them unavoidable errors, or by transporting to and fro a large number of chronometers between the principal observatory and the position to be located; and in this method it can be conceived that errors would be involved, no matter how thorough the theoretical compensation for error of the instruments.

By the aid of telegraph and radio, differences of longitude are determined with great accuracy, and an ever-increasing number of secondary meridional positions are thus established over the world; these afford the necessary bases in carrying on the surveys to map correctly the various coast lines, and render possible the publication of reliable and accurate navigators' charts.

338. To determine telegraphically the difference of longitude between two points, a small observatory containing a transit instrument, chronograph, break-circuit sidereal chronometer, and a set of telegraph instruments is established at each of the two points, and, being connected by a temporary wire with the cable or land line at each place, the two observatories are placed in telegraphic communication with each other.

By means of transit observations of stars, the error of the chronometer at each place on its own local sidereal time is well determined, and the chronometers are then accurately compared by signals sent first one way and then the other, the times of sending and receiving being very exactly noted at the respective stations. The error of each chronometer on local sidereal time being applied to its reading, the difference between the local times of the two places may be found, and consequently the difference of longitude. The time of transmission over the telegraph line is eliminated by sending signals both ways. By the employment of chronometers keeping sidereal time, the computation is simplified, though mean-time chronometers may be used.

339. Establishment of Tertiary Meridians.—Let it be supposed that the meridional distance between A and B is to be measured, of which A is a *secondary* meridional position accurately determined, and B a *tertiary* meridional position to be determined.

If possible, two sets of observations should be taken at A to ascertain the errors and rates of the chronometers. The run is then made to B, and observations made to determine local time, and hence the difference of longitude; and on the same spot altitudes of the sun, or of a number of pairs of stars, or both, should be taken to determine the latitude.

Now, if chronometer rates could be relied on to be uniform, this measurement would suffice, but since variations may always arise, the run back to A should be made, or to another secondary meridional position, C, and new rates there obtained. Finally, the errors of the chronometers on the day when the observations were made at the tertiary position should be corrected for the loss or gain in rate, and for the difference of the errors as thus determined.

When opportunity does not permit obtaining a *rate* at the secondary meridional station or stations, both before and after the observations at B, the navigator may obtain the *errors* only, and assume that the rate has been uniform between those errors.

A modification of the foregoing method which may sometimes prove convenient is to make the first and third sets of observations at the position of the tertiary meridian, and the intermediate one at the secondary meridian; in this case the error will be obtained at the secondary station and the rate at the tertiary.

Example: A vessel at a station A, of known longitude, obtained chronometer errors as follows:

May 27, noon, chro. slow, $7^{m}\ 18^{s}.9$,
June 3, noon, chro. slow, $7\ \ 12\ .7$;

then proceeding to a station B a series of observations for longitude was taken on June 17; after which, returning to A, the following errors were obtained:

July 3, noon, chro. slow, $7^{m}\ 00^{s}.7$,
July 10, noon, chro. slow, $6\ \ 59\ .8$.

Required the correct error on June 17.

May 27,	$-7^{m}\ 18^{s}.9$	July 3,	$-7^{m}\ 00^{s}.7$
June 3,	$-7\ \ 12\ .7$	July 10,	$-6\ \ 59\ .8$
Change,	$+\ \ 6\ .2$	Change,	$+\ \ 0\ .9$
Daily rate,	$+\ \ 0^{s}.89$	Daily rate,	$+\ \ 0^{s}.13$

Therefore, assuming that these rates were correct at the middle of the periods for which they were determined, we have,

May 30, Midnight, Rate,	$+0^{s}.89$
July 6, Midnight, Rate,	$+0\ .13$
Change of rate, 37 days,	$-0\ .76$
Daily change of rate,	$-0^{s}.021$

Change of rate for 3½ days, $-0^{s}.07$; rate June 3, noon, $+0^{s}.89-0^{s}.07=+0^{s}.82$
Change of rate for 17½ days, $-0\ .37$; rate June 17, noon, $+0\ .89-0\ .37=+0\ .52$

Mean daily rate, June 3 to 17,	$+0\ .67$
Total change of error, June 3 to 17,	$+0^{m}\ 09^{s}.38$
Error, June 3,	$-7\ \ 12\ .7$
Error, June 17,	$-7\ \ 03\ .3$

340. Single Altitudes.—The determination of longitudes on shore by single altitudes of a celestial body is identical in principle with the determination at sea by that method, which will be explained hereafter (art. 341). It may be remarked, however, that by taking observations on opposite sides of the meridian, at altitudes as nearly equal as possible, a means is afforded, which is not available at sea, of eliminating certain constant errors of observation.

DETERMINATION AT SEA.

341. The Time Sight.—A method of determining longitude at sea is that of the *time sight,* sometimes called the *chronometer method*. The altitude of the body above the sea horizon is measured with a sextant and the chronometer time noted; the hour angle of the body is then found by the process described in article 316, Chapter XI.

If the sun is observed, the hour angle is equal to the local apparent time; the Greenwich apparent time may be determined by applying the equation of time to the Greenwich mean time as shown by the chronometer; the longitude is then equal to the difference between the local and the Greenwich apparent times, being east when the local time is the later and west when it is the earlier of the two.

If any other celestial body is employed, the hour angle from the local meridian, found from the sight, is compared with the hour angle from the Greenwich meridian to obtain the longitude; the Greenwich hour angle is found by converting the Greenwich mean time into Greenwich sidereal time in the usual manner, and then taking the difference between the latter and the right ascension of the body, the remainder being marked east or west, according as the Greenwich sidereal time is the lesser or greater of the two quantities; and as the local hour angle may be marked east or west according to the side of the meridian upon which it was observed, the name of the longitude will be indicated in combining the quantities.

342. As has been stated, the most favorable position of the celestial body for finding the hour angle from its altitude is when nearest the prime vertical, provided the altitude is not so small as to be seriously affected by refraction.

343. In determining the longitude at sea by this method, it is necessary to employ the latitude by account. This is seldom exactly correct, and a chance of error is therefore introduced in the resulting hour angle; the magnitude of such an error depends upon the position of the body relative to the observer. The employment of the Sumner line, which is to be explained in a later chapter, insures the navigator against being misled by this cause, and its importance is to be estimated accordingly.

Example: At sea, May 18, 1916, a. m.; Lat. 41° 33′ N.; Long. 33° 37′ W., by D. R., the following altitudes of the sun's lower limb were observed, and times noted by a watch compared with the Greenwich chronometer. Chro. corr., $+4^m\ 59^s.2$; I. C., −30″; height of the eye, 23 feet; C−W, $2^h\ 17^m\ 06^s$. Required the true longitude.

W. T.,		7^h	20^m	15^s
			20	47
			21	14
Mean,		7	20	45 .3
C−W,	+	2	17	06
Chro. t.,		9	37	51 .3
C. C.,	+		4	59 .2
G. M. T., 17d,		21	42	50 .5
Eq. t.,	+		3	44 .1
G. A. T.,		21	46	34 .6

Obs. alt. ⊙,		29°	35′	30″
			41	20
			46	10
Mean,		29	41	00
Corr.,	+		9	04
h,		29	50	04
(Tab. 46),	+		9′	34″
I. C.,	−		0′	30″
Corr.,	+		9′	04″

Dec., 17d 20h,		19° 30′.3 N.
H. D.,	+	0′.6
G. M. T.,		$1^h.7$
Corr.,	+	1′.02
Dec.,		19° 31′ 18″ N.
p,		70° 28′ 42″

Eq. t., 17d 20h,		$3^m\ 44^s.3$
H. D.,	−	$0^s.1$
G. M. T.,		$1^h.7$
Corr.,	−	$0^s.17$
Eq. t.,		$3^m\ 44^s.1$

(*Add to mean time.*)

h,	29° 50′ 04″		
L,	41 33 00	sec.,	.12588
p,	70 28 42	cosec.,	.02571
	2)141 51 46		
s,	70 55 53	cos.,	9.51415
s−h,	41 05 49	sin.,	9.81779
			2)19.48353
G. A. T.,	$21^h\ 46^m\ 34^s.6$	sin. ½ t,	9.74176
L. A. T.,	19 32 05 .5		
Long.,	$2^h\ 14^m\ 29^s.1$ 33° 37′ 16″ W.		

Example: At sea, April 16, 1916, p. m., in Lat. 11° 47′ S., Long. 0° 20′ E., by D. R., observed an altitude of the star Aldebaran, west of the meridian, 23° 13′ 20″; chronometer time, 6^h 58^m 29^s, chronometer fast of G. M. T., 2^m 27^s; I. C., −2′ 00″; height of eye, 26 feet. What was the longitude?

Chro. t.,		6^h	58^m	29^s
C. C.,	−		2	27
G. M. T.,		6	56	02
R. A. M. S.,	+	1	37	11
Red. (Tab. 9),	+		1	09
G. S. T.,		8	34	22
R. A. ✱,		4	31	07
H. A. from Gr.,		4	03	15 W.

Obs. alt. ✱,		23°	13′	20″
Corr.,	−		9	15
h,		23	04	05
(Tab. 46),	−		7′	15″
I. C.,	−		2	00
Corr..,	−		9	15

R. A. ✱,	4^h	31^m	$06^s.8$	
Dec.,	16°	20′	36″	N.
p,	106°	20′	36″	

h,	23°	04′	05″		
L,	11	47	00	sec	.00925
p,	106	20	36	cosec	.01791
	2)141	11	41		
s,	70	35	50	cos	9.52141
$s-h$,	47	31	45	sin	9.86783
Gr. H. A.,	4^h	03^m	15^s W.		2)19.41640
H. A.,	4	05	42 W.	sin ½ t	9.70820
Long.,	0^h	02^m	27^s E.		
	0°	36′	45″ E.		

Example: At sea, July 26, 1916, a. m., in Lat. 25° 12′ S., Long. 75° 30′ W., by D. R., observed an altitude of the planet Jupiter, east of the meridian, 32° 46′ 10″; watch time, 2^h 48^m 02^s; C−W, 5^h 05^m 42^s; C. C., $+2^m$ 18^s; I. C., +1′ 30″; height of eye, 18 feet. Required the longitude.

W. T.,		2^h	48^m	02^s
C−W,		5	05	42
Chro. t.,		7	53	44
C. C.,	+		2	18
G. M. T., 25^d,		19	56	02
R. A. M. S., 0^h,	+	8	11	26.8
Red. (Tab. 9),	+		3	16.5
G. S. T.,		4	10	45.3
R. A. ✱,		2	08	38
H. A. from Gr.,		2	02	07.3 W.

Obs. alt. ✱		32°	46′	10″
Corr.,	−		4	09
h,		32	42	01
(Tab. 46),	−		5′	39″
I. C.,	+		1	30
Corr.,	−		4	09

R. A., 25^d 0^h,		2^h	08^m	20^s	
Corr.	+			18	
R. A.,		2	08	38	
Dec. 25^d 0^h,		11°	35′.9		N.
Corr.,	+		1.4		
Dec.,		11°	37′	18″	N.
p,		101°	37′	18″	

H. D.,	+	$0^s.9$
G. M. T.,		$19^h.9$
Corr.,	+	$17^s.9$
H. D.,	+	0′.07
G. M. T.,		$19^h.9$
Corr.,	+	1′.39

h.,	32°	42′	01″		
L,	25	12	00	sec	.04343
p,	101	37	18	cosec	.00900
	2)159	31	19		
s,	79	45	40	cos	9.24983
$s-h$,	47	03	39	sin	9.86456
Gr. H. A.,	2^h	02^m	07^s W.		2)19.16682
H. A.,	3	00	15 E.	sin ½ t	9.58341
Long.,	5^h	02^m	22^s W.		
	75°	35′	30″ W.		

CHAPTER XIV.

AZIMUTH.

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344. The *azimuth* of a body has been defined (art. 223, Chap. VII) as the arc of the horizon intercepted between the meridian and the vertical circle passing through the body; and the *amplitude* (art. 224) as the arc measured between the position of the body when its true altitude is zero and the east or west point of the horizon. The amplitude is measured from the east point at rising and from the west point at setting, and, if added to or subtracted from 90°, will agree with the azimuth of the body when in the true horizon. The azimuth is usually measured from the north point of the horizon in north latitude, and from the south point in south latitude, through 180° to the east or west; thus, if a body bore N. by E., its azimuth would be named N. 11¼° E. in north, or S. 168¾° E. in south latitude.

The determination of the azimuth of a celestial body is an operation of frequent necessity. At sea, the comparison of the true bearing with a bearing by compass affords the only means of ascertaining the error of the compass due to variation and deviation; on shore, the azimuth is required in order to furnish a knowledge of the variation, and is further essential in all surveying operations, the true direction of the base line being thus obtained.

345. There are various methods of obtaining the true azimuth of a celestial body, which will be described as follows: (*a*) *Amplitudes,* (*b*) *Time Azimuths,* (*c*) *Altitude Azimuths,* (*d*) *Time and Altitude Azimuths.* A further method, by means of the Summer line, will be explained later (Chap. XV). Still another operation pertains to this subject, namely: (*e*) The determination of the *True Bearing of a Terrestrial Object.*

AMPLITUDES.

346. The method of obtaining the compass error by amplitudes consists in observing the compass bearing of the sun or other celestial body when its center is in the true horizon, the true bearing, under such conditions, being obtained by a short calculation. Since the true horizon is not marked by any visible line (differing as it does from the visible horizon by reason of the effects of refraction, parallax, and dip), allowance may be made for the difference by an estimate of the eye, or else the observation may be made in the visible horizon and a correction applied.

347. When the center of the sun is at a distance above the horizon equal to its own diameter it is almost exactly in the true horizon; at such a time, note its bearing by compass, and also note (as in all observations for determining compass error) the ship's head by compass, and the angle and direction of the ship's heel.

Or, note the bearing at the instant at which the center of the body is in the visible horizon; in the case of the sun and moon, the correct bearing at that time may be most accurately ascertained by taking the mean of the bearings when the upper and the lower limbs of the disk are just appearing or disappearing.

348. *To find the true amplitude by computation,* there are given the latitude, L, and declination, d. The quantities are connected by the formula,

$$\sin \text{Amp.} = \sec L \sin d,$$

from a solution of which the amplitude is obtained..

To find the true amplitude by inspection enter Table 39 with the declination at the top and the latitude in the side column; under the former and opposite the latter will be given the true amplitude. To obtain accurate results, interpolate for minutes of latitude and declination.

To reduce the observed amplitude when taken in the visible horizon to what it would have been if taken in the true horizon, enter Table 40 with the latitude and declination to the nearest degree and apply the correction there found to the observed amplitude; the result will be the corrected amplitude by compass, which, by comparison with the true amplitude, gives the compass error. When the body observed is the sun, a star, or a planet, apply the correction, at rising in north latitude or at setting in south latitude, to the *right*, and at setting in north latitude or at rising in south latitude, to the *left*. For the moon, apply half the correction in a contrary direction.

Example: At sea, in Lat. 11° 29′ N., the observed bearing of the sun, at the time of rising, when its center was estimated to be one diameter above the visible horizon, was E. 31° N.; corrected declination 22° 32′ N. Required the compass error.

By computation.

L	11° 29′	sec	.00878
d	22 32	sin	9.58345
True amp.	E. 23° 01′ N.	sin	9.59223
Obs. amp.	E. 31 00 N.		
Error,	7° 59′ E.		

By inspection (*Table 39*).

L, 11°.5 N.	True amp.	E. 23°.0 N.
d, 22 .5 N.		
Obs. amp.		E. 31 .0 N.
Error,		8°.0 E.

Example: At sea, in Lat. 25° 03′ S., the observed bearing of Venus, when in the visible horizon at rising, was E. 18° 30′ N., its declination being 21° 44′ N. Required the compass error.

By computation.

L	25° 03′	sec	.04290
d	21 44	sin	9.56854
True amp.	E. 24° 08′ N.	sin	9.61144
Comp. amp.	E. 18 48 N.		
Error,	5° 20′ W.		

By inspection (*Table 39*).

L,	25°.0 S.	True amp.	E. 24°.1 N.
d,	21 .7 N.		
Obs. amp.	E. 18°.5 N.	Comp. amp.	E. 18 .8 N.
Corr. (Tab. 40)	0.3 left.		
Error,			5°.3 W.

Example: At sea, in Lat. 40° 27′ N., the mean of the observed bearings of the upper and lower limbs of the moon, when in contact with the visible horizon at setting, was W. 17° S.; declination, 21° 12′ S. What was the error of the compass?

By computation.

L	40° 27′	sec	.11863
d	21 12	sin	9.55826
True amp.	W. 28° 22′ S.	sin	9.67689
Comp. amp.	W. 16 42 S.		
Error,	11° 40′ W.		

By inspection (*Table 39*).

L,	40°.5 N.	True amp.	W. 28°.4 S.
d,	21 .2 S.		
Obs. amp.	W. 17° .0 S.	Comp. amp.	W. 16 .7 S.
Corr. (Tab. 40)	0.3 right.		
Error,			11°.7 W.

TIME AZIMUTHS.

349. In this method are given the hour angle, t, at time of observation, the polar distance, p, and the latitude, L; to find the azimuth, Z.

Any celestial body bright enough to be observed with the azimuth circle may be employed for observation; the conditions are, however, most favorable for solution when the altitude is low.

350. Take a bearing of the object, bisecting it if it has an appreciable disk, and note the time with a watch of known error. Record, as usual, the ship's head by compass and the amount of heel. If preferred, a series of bearings may be taken with their corresponding times, and the means taken.

351. First prepare the data as follows:

(*a*) Find the Greenwich time corresponding to the local time of observation.

(*b*) Take out the declination of the body from the Nautical Almanac; if the method of computation is employed, the polar distance and the co-latitude should be noted.

(*c*) Find the hour angle of the body by rules heretofore given.

This having been done, the true azimuth may be determined either by *Time Azimuth Tables*, by the graphic method of an *Azimuth Diagram*, or by *Solution of the Astronomical Triangle*. Owing to the possibility of more expeditious working, either of the first-named two is to be considered preferable to the last, and the navigator is recommended to supply himself with a copy of a book of Azimuth Tables, such as published by the Hydrographic Office, or with an Azimuth Diagram such as Weir's or Sigsbee's; an explanation of the method of use accompanies each of these.

352. To solve the triangle:

Let $S = \frac{1}{2}$ sum of polar distance and co-Lat.
$D = \frac{1}{2}$ difference of polar distance and co-Lat.
$\frac{1}{2}t = \frac{1}{2}$ hour angle.
$Z =$ true azimuth.

Then,
$$\tan X = \sin D \operatorname{cosec} S \cot \tfrac{1}{2} t;$$
$$\tan Y = \cos D \sec S \cot \tfrac{1}{2} t;$$
$$Z = X + Y, \text{ or } X \sim Y.$$

First Case.—If the half-sum of the polar distance and co-Lat. is *less* than 90°: take the sum of the angles X and Y, if the polar distance is *greater* than the co-Lat.; take the difference, if the polar distance is *less* than the co-Lat.

Second Case.—If the half-sum of the polar distance and co-Lat. is *greater* than 90°: always take the difference of X and Y, which subtract from 180°, and the result will be the true azimuth.

In either case, mark the true azimuth N. or S. according to the latitude, and E. or W. according to the hour angle. It may sometimes be convenient to use the supplement of the true azimuth, by subtracting it from 180° and reversing the prefix N. or S., in order to make it correspond to the compass azimuth when the latter is less than 90°.

The cotangent of half the hour angle may be found from Table 44 abreast the *whole* hour angle in the column headed "Hour P. M."

Example: At sea, in Lat. 30° 25′ N., Long. $5^h\ 25^m\ 42^s$ W., the observed bearing of sun's center was N. 135° 30′ E., and the Greenwich mean time, December 3, $2^h\ 36^m\ 11^s$. The corrected declination of the sun was 22° 07′ S.; the equation of time (additive to mean time), $10^m\ 03^s$. Required the error of the compass.

G. M. T.(Dec. 3),	$2^h\ 36^m\ 11^s$	co-Lat.,	59° 35′	t	$2^h\ 39^m\ 28^s$	cot ½ t	.44051	cot ½ t	.44051
Long.,	− 5 25 42	p,	112 07	S	85° 51′	cosec	.00114	sec	1.14045
				D	26 16	sin	9.64596	cos	9.95267
L. M. T.(Dec. 2),	21 10 29	p+co-L,	171 42						
Eq. t.,	+ 10 03			X	50 44	tan	.08761		
		S,	85 51	Y	88 19			tan	1.53363
L. A. T.,	21 20 32								
		p−co-L,	52° 32′	X+Y	139 03				
t,	$2^h\ 39^m\ 28^s$								
		D,	26 16						

True azimuth,	N. 139° 03′ E.
Comp. azimuth,	N. 135 30 E.
Compass error,	3 33 E.

Example: At sea, in Lat. 2° 16′ N., the observed bearing of the sun's center was N. 85° 15′ E: sun's hour angle, $3^h\ 44^m\ 16^s$, and its declination, 7° 38′ N. Required the compass error.

co-Lat.,	87° 44′	t	$3^h\ 44^m\ 16^s$	cot ½ t	.27372	cot ½ t	.27372
p,	82 22	S	85° 03′	cosec	.00162	sec	1.06406
		D	2 41	sin	8.67039	cos	9.99952
p+co-L,	170 06						
		X	5 03	tan	8.94573		
S,	85 03	Y	87 22			tan	1.33730
co-L−p,	5° 22′	Y−X	82 19				
D,	2 41						

True azimuth,	N. 82° 19′ E.
Comp. azimuth,	N. 85 15 E.
Compass error,	2 56 W

Example: At sea, in Lat. 16° 32′ S., observed bearing of Venus N. 56° 00′ W., its hour angle being $4^h\,27^m\,31^s$, and its declination 23° 12′ N. What was the error of the compass?

co-Lat.,	73° 28′	t	$4^h\,27^m\,31^s$	cot ½ t	.18022	cot ½ t	.18022
p,	113 12	S	93° 20′	cosec	.00074	sec	1.23549
		D	19.52	sin	9.53126	cos	9.97335
p+co-L,	186 40						
		X	27 16	tan	9.71222		
S,	93 20	Y	87 40			tan	1.38906
p−co-L,	39° 44′	Y−X	60 24				
D,	19 52	Z	119° 36′				

True azimuth,	S. 119° 36′	W.
Comp. azimuth,	S. 124 00	W.
Compass error,	4 24	W.

ALTITUDE AZIMUTHS.

353. This method is employed when the altitude of the body is observed at the same time as the azimuth; in such a case the hour angle need not be known, though the time of observation should be recorded with sufficient accuracy for the correction of the declination of the sun, moon, or a planet.

There are given the altitude, h, the polar distance, p, and the latitude, L; to find the azimuth, Z.

354. Take a bearing of the body by compass, bisecting it if the disk is of appreciable diameter, and simultaneously measure the altitude; note the time approximately. Observe also the ship's heading (by compass) and the heel.

Or a series of azimuths, with corresponding altitudes, may be observed, and the means employed.

355. Calculate the true altitude and declination from the observed altitude and the time. Then compute the true azimuth from the following formula:

$$\cos \tfrac{1}{2} Z = \sqrt{\cos s \cos (s-p) \sec L \sec h,}$$

in which $s = \frac{1}{2}(h+L+p)$. The resulting azimuth is to be reckoned from the north in north latitude and from the south in south latitude.

It may occur that the term, $(s-p)$, will have a negative value, but since the cosine of a negative angle less than 90° is positive, the result will not be affected thereby.

Example: At sea, in Lat. 30° 25′ N., the observed bearing of the sun's center was N. 135° 30′ E., and its corrected altitude 24° 59′; the approximate G. M. T. was $2^h.6$, the declination at that time being 22° 07′ S. Required the compass error.

h	24° 59′	sec	.04267
L	30 25	sec	.06431
p	112 07		
	2) 167 31		
s	83 45	cos	9.03690
$s-p$	−28 22	cos	9.94445
			2) 19.08833
½ Z	69 30	cos	9.54416
Z	139 00		

True azimuth,	N. 139° 00′	E.
Comp. azimuth,	N. 135 30	E.
Compass error,	3 30	E.

TIME AND ALTITUDE AZIMUTHS.

356. When, at the time of observing the compass bearing of a celestial body, the altitude is measured and the exact time noted, the true azimuth may be very expeditiously determined, a knowledge of the latitude being unnecessary.

In view of the simplicity of the computation, this method strongly commends itself to observers not provided with azimuth tables or diagram.

357. The observation is identical with that of the altitude azimuth (art. 354), with the exception that the times of observation must be *exactly* instead of *approximately* noted.

358. Ascertain the declination of the body at time of sight, and correct the observed altitude; compute the hour angle. We then have:

$$\sin Z = \sin t \cos d \sec h,$$

from which the azimuth may be found.

This method has a defect in that there is nothing to indicate whether the resulting azimuth is measured from the north or the south point of the horizon; but as the approximate azimuth is always known, cases are rare when the solution will be in question.

Example: At sea, in Lat. 30° 25′ N., Long. $5^h\ 25^m\ 42^s$ W., the observed bearing of the sun's center was N. 135° 30′ E.; its altitude at the time was 24° 59′; hour angle, $2^h\ 39^m\ 28^s$ (39° 52′), and declination, 22° 07′ S. Find the compass error. (See example under Altitude Azimuths and first example under Time Azimuths.)

t	39° 52′	sin	9.80686	True azimuth,	N. 139° 04′ E.
d	22 07	cos	9.96681	Comp. azimuth,	N. 135 30 E.
h	24 59	sec	.04267		
				Compass error,	3 34 E.
Z	S. 40° 56′ E.	sin	9.81634		

TRUE BEARING OF A TERRESTRIAL OBJECT.

359. Thus far, sea observations for combined variation and deviation have been discussed, but if it becomes necessary, as in surveying, to ascertain the *True Bearing of a Terrestrial Object*, or to find the variation at a shore station, more accurate methods than the foregoing must be resorted to.

The most reliable method is that by an *Astronomical Bearing*. This consists in finding the true bearing of some well-defined object by taking the angle between it and the sun or other celestial body with a sextant or a theodolite, and simultaneously noting the time by chronometer, or measuring the altitude, or observing both time and altitude. It should always be noted whether the object is right or left of the sun.

360. *By Sextant.*—Measure the angular distance between the object and the sun's limb; and if there is a second observer, measure the altitude of the sun at the same moment and note the time. In the absence of an assistant, first measure the altitude of the sun; next, the angular distance between the sun and the object; then, a second altitude of the sun, noting the time of each observation. Also measure the altitude of the defined point above the sea or shore horizon.

By Theodolite.—This instrument is far more convenient than the sextant, for, being leveled, the horizontal angle between the sun and the object is at once given, no matter what may be the altitudes of the objects. In case the altitude of the sun is needed, it may be read accurately enough from the vertical circle, although not as finely graduated as the limb of the sextant. The error in altitude must, however, be found by the level attached to the telescope, since it will usually be found to differ from the levels of the horizontal circle. If, in directing the telescope to the sun, there is no colored eyepiece, an image of the sun may be cast on a piece of white paper held at a little distance from the eyepiece, and by adjusting the focus the shadow of the cross wires will be seen.

It should be understood that any celestial body may be used as well as the sun, and there are, in fact, certain advantages in the use of the stars; the sun is chosen for illustration, because it will usually be found most convenient to employ that body.

361. Find the true azimuth of the celestial body by one of the methods previously explained in this chapter, and apply to it the azimuth difference, or horizontal angle between the celestial and the terrestrial body, having regard to the direction of one from the other.

To find the azimuth difference from sextant observations, change the observed altitudes of the bodies into *apparent* altitudes by correcting them for index error of the sextant, dip, and semidiameter; change the observed angular distance into *apparent* angular distance, by correcting for index error and semidiameter. Then if $S = \frac{1}{2}$ (App. Dist. + App. Alt. ☉ + App. Alt. Object), we have:

$$\cos \tfrac{1}{2} \text{ Az. Diff.} = \sqrt{\sec \text{App. Alt.}\odot \sec \text{App. Alt. Object} \cos S \cos (S - \text{App. Dist.})},$$

whence the azimuth difference is deduced.

When the theodolite is used, the horizontal angle is given directly. If only one limb of the sun is observed, it will be necessary to apply a correction for semidiameter (S. D. × sec h), but it is usual to eliminate this correction by taking the mean of observations of both limbs.

Example: From a. m. observations, in Lat. 30° 25′ 24″ N., Long. 81° 25′ 24″ W., obtained the following data for finding the true bearing of a station:

Watch time,	$11^h\ 22^m\ 36^s$	Obs. Ang. Dist. |⊙,	117° 07′ Left.	Dec. S.,	22° 56′ 27″
C−W,	5 21 18	Obs. 2 ⊙̲,	71° 37′ 20″	Eq. t., +	$7^m\ 00^s$
Chro. corr., +	2 16	Obs. alt. Station,	20′	S. D.,	16′ 17″
		I. C.,	zero.		

Required the true bearing of the object.

W. T.,		11^h	22^m	36^s
C−W,		5	21	18
Chro. t.,		4	43	54
C. C.,	+		2	16
G. M. T.,		4	46	10
Eq. t.,	+		7	00
G. A. T.,		4	53	10
Long.,	−	5	25	42
L. A. T.,		23	27	28
t,		$\begin{cases} 0^h\ 32^m\ 32^s \\ 8°\ 08′\ 00″ \end{cases}$		

2⊙̲,		71°	37′	20″
⊙̲,		35	48	40
S. D.,	+		16	17
App. Alt.,		36	04	57
p. & r.,	−		1	13
h,		36	03	44

t		8°	08′	00″	sin	9.15069
d		22	56	27	cos	9.96422
h		36	03	37	sec	.09239
Z {	S.	9°	17′	E.	sin	9.20730
	N.	170	43	E.		

Obs. Ang. Dist.,		117°	07′	00″
⊙'s S. D.,	+		16	17
App. Ang. Dist.,		117	23	17

App. Dist.	117°	23′	
App Alt. ⊙	36	05	sec 0.09250
App. Alt. Object		20	sec 0.00001
	2)153	48	
S	76	54	cos 9.35536
S−App. Dist.	−40	29	cos 9.88115
			2)19.32902
½ Az. Diff.	62°	30′	cos 9.66451
Az. Diff.	125	00	

True bearing ⊙,	170°	43′	E.
Az. Diff.,	125	00	Left.
True bearing object, N.	45°	43′	E.

Example: Same date and place and same objects as in the preceding example; measurement made with a theodolite, angular distance ϕ, 123° 17′; object left of sun. Watch time, $11^h\ 16^m\ 34^s.5$; watch slow of L. A. T., $4^m\ 53^s.5$. Dec. ⊙, 22° 56′ S. Required the true bearing. (See article 352.)

W. T.,	11^h	16^m	$34^s.5$
W. slow, +		4	53 .5
L. A. T.,	23	21	28 .0
t,	0	38	32

co-Lat.,	59°	35′
p,	112	56
p+co-L,	172	31
S,	86	15
p−co-L,	53	21
D,	26	41

t	0^h	38^m	32^s
S	86°	15′	
D	26	41	
X	79°	24′	
Y	89	39	
X+Y	169	03	

cot ½ t	1.07435	cot ½ t	1.07435
cosec	.00093	sec	1.18440
sin	9.65230	cos	9.95110
tan	.72758		
		tan	2.20985

True bearing ⊙,	N. 169°	03′	E.
Az. Diff.,	123	17	Left.
True bearing object, N.	45	46	E.

CHAPTER XV.

THE SUMNER LINE.

DESCRIPTION OF THE LINE.

362. The method of navigation involving the use of the Sumner line takes its name from Capt. Thomas H. Sumner, an American shipmaster, who discovered it and published it to the world. As a proof of its value, the incident which led to its discovery may be related:

"Having sailed from Charleston, S. C., 25th November, 1837, bound for Greenock, a series of heavy gales from the westward promised a quick passage; after passing the Azores the wind prevailed from the southward, with thick weather; after passing longitude 21° W. no observation was had until near the land, but soundings were had not far, as was supposed, from the bank. The weather was now more boisterous, and very thick, and the wind still southerly; arriving about midnight, 17th December, within 40 miles, by dead reckoning, of Tuskar light, the wind hauled SE. true, making the Irish coast a lee shore; the ship was then kept close to the wind and several tacks made to preserve her position as nearly as possible until daylight, when, nothing being in sight, she was kept on ENE. under short sail with heavy gales. At about 10 a. m. an altitude of the sun was observed, and the chronometer time noted; but, having run so far without observation, it was plain the latitude by dead reckoning was liable to error and could not be entirely relied upon.

The longitude by chronometer was determined, using this uncertain latitude, and it was found to be 15′ E. of the position by dead reckoning; a second latitude was then assumed 10′ north of that by dead reckoning, and toward the danger, giving a position 27 miles ENE. of the former position; a third latitude was assumed 10′ farther north, and still toward the danger, giving a third position ENE. of the second 27 miles. Upon plotting these three positions on the chart, they were seen to be in a straight line, and this line passed through Smalls light.

"It then at once appeared that the observed altitude must have happened at all the three points and at Smalls light and at the ship at the same instant."

Then followed the conclusion that, although the absolute position of the ship was uncertain, she must be somewhere on that line. The ship was kept on the course ENE., and in less than an hour Smalls light was made, bearing ENE. ½ E. and close aboard.

The latitude by dead reckoning was found to be 8′ in error, and if the position given by that latitude had been assumed correct, the error would have been 8 miles too far S., and 31′ 30″ of longitude too far W., and the result to the ship might have been disastrous had this wrong position been adopted. This represents one of the practical applications of the Sumner line.

The properties of the line thus found will now be explained.

363. Circles of Equal Altitude.—In figure 54, if EE′E″ represent the earth projected upon the horizon of a point A, and if it be assumed that, at some particular instant of time, a celestial body is in the zenith of that point, then the true altitude of the body as observed at A will be 90°. In such a case the great circle EE′E″, which forms the horizon of A, will divide the earth into two hemispheres, and from any point on the surface of one of these hemispheres the body will be visible, while over the whole of the other hemisphere it will be invisible. The great circle EE′E″, from the fact of its marking the limit of illumination of the body, is termed the *circle of illumination*, and from any point on its circumference the true altitude of the center of the body will be zero. If, now, we consider any small circle of the sphere, BB′B″, CC′C″, DD′D″, whose plane is parallel to the plane of the circle of illumination and which lies within the hemisphere throughout which the body is visible, it will be apparent that the true altitude of the body at any point of the circumference of one of these circles is equal to its true altitude at any other point of the same circumference; thus the altitude of the body at B is equal to its altitude at B′ or B″, and its altitude at D is the same as at D′ or D″.

It therefore follows that at any instant of time there is a series of positions on the earth at which a celestial body appears at the same given altitude, and these positions lie in the circumference of a circle described upon the earth's surface whose center is at that position which has the body in the zenith, and whose radius depends upon the zenith distance, or—what is the same thing—upon the altitude. Such circles are termed *circles of equal altitude*. It is important to note that an observer making an instantaneous transit through the latitudes and longitudes passed over by any rhumb line or loxodromic curve drawn within the hemisphere of illumination, through the point A, will experience no astronomical difference, with reference to the observed body in the zenith of A, save an altitude difference.

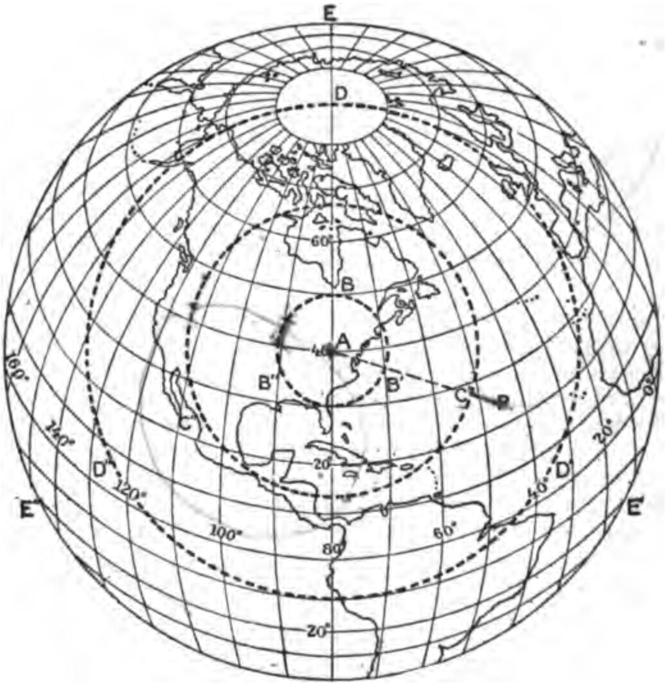

FIG. 54.

364. The data for an astronomical sight comprise merely the time, declination, and altitude. The first two fix the position of the body and may be regarded as giving the latitude and longitude of that point on the earth in whose zenith the body is found; the zenith distance (the complement of the altitude) indicates the distance of the observer from that point; but there is nothing to show at which of the numerous positions fulfilling the required conditions the observation may have been taken. A number of navigators may measure the same altitude of a body at the same instant of time, at places thousands of miles apart; and each proceeds to work out his position with identical data, so far as this sight is concerned. It is therefore clear that a single observation is not enough, in itself, to locate the point occupied by the observer, and it becomes necessary, in order to fix the position, to employ a second circle, which may be either that of another celestial body or that of the same body given by an observation when it is in the zenith of some other point than when first taken; knowing that the point of observation lies upon each of two circles, it is only possible that it can be at one of their two points of intersection; and since the position of the ship is always known within fairly close limits, it is easy to choose the proper one of the two. Figure 55 shows the plotting of observations of two bodies vertically over the points A and A′ upon the earth, the zenith distances corresponding respectively to the radii AO and A′O.

365. THE SUMNER LINE.—In practice, under the conditions existing at sea, it is never necessary to determine the whole of a circle of equal altitude, as a very small portion of it will suffice for the purposes of navigation; the position is always known within a distance which will seldom exceed 30 miles under the most unfavorable conditions, and which is usually very much less; in the narrow limits thus required, the arc of the circle will practically coincide with the tangent at its middle point, and may be regarded as a straight line. Such a line, comprising so much of the circle of equal altitude as covers the probable limits of position of the observer, is called a *Sumner line* or *Line of position*.

The latter designation has also a more extended meaning, embracing any line, straight or curved, which forms a locus of the ship's position, whether it be obtained from observations of celestial bodies or from bearings or distances of terrestrial objects.

366. Since the direction of a circle at any point—that is, the direction of the tangent—must be perpendicular to the radius at that point, it follows that the Sumner line always lies in a direction at right angles to that in which the body bears from the observer. Thus, in figure 55, it may be seen that *m m′* and *n n′*, the extended Sumner lines corresponding to the bodies at A and A′, are respectively perpendicular to the bearings of the bodies OA and OA′. This fact has a most important application in the employment of the Sumner line.

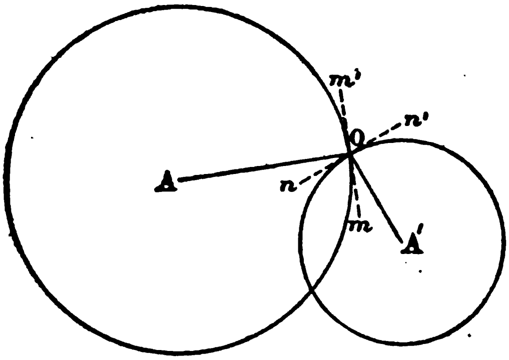

Fig. 55.

367. Uses of the Sumner Line.—The Sumner line is valuable because it gives to the navigator a knowledge of all of the probable positions of his vessel, while a sight worked with a single assumed latitude or longitude gives but one of the probable positions; it must be recognized that, in the nature of things, an error in the assumed coordinate will almost invariably exist, and its possible effect should be taken into consideration; the line of position reveals the difference of longitude due to an error in the latitude, or the reverse.

Since the Sumner line is at right angles to the bearing, it may be seen that when the body bears east or west—that is, when it is on the prime vertical—the resulting line runs north and south, coinciding with a meridian; if, in this case, two latitudes are assumed, the deduced longitudes will be the same. When the body bears north or south, or is on the meridian, the line runs east and west, and becomes identical with a parallel of latitude; in such a case, two assumed longitudes will give the same latitude. Any intermediate bearing gives a Sumner line inclined to both meridians and parallels; if the line agrees in direction more nearly with the meridian, latitude should generally be assumed and the longitude worked; if it is nearer a parallel, the reverse course is usually preferable. The values of the assumed coordinates may vary from 10′ to 1°, according to circumstances.

368. The greatest benefit to be derived from the Sumner method is when two lines are worked and their intersection found. The two lines may be given by different bodies, which is generally preferable, or two different lines may be obtained from the same body from observations taken at different times. The position given by the intersection of two lines is more accurate the more nearly the lines are at right angles to each other, as an error in one line thus produces less effect upon the result. When two observations of the same body are taken, the position of the ship at the time of first sight must be brought forward to that at the second in considering the intersection; if, for example, a certain line is determined, and the ship then runs NW. 27 miles, it is evident that her new position is on a line parallel with the first and 27 miles to the NW. of it; a second line being obtained, the intersection of this with the first line, as corrected for the run, gives the ship's position.

Besides the employment of two lines for intersection with each other, a single line may be made to serve various useful purposes for the navigator. These are described in article 389, Chapter XVI.

METHODS OF DETERMINATION.

369. There are three methods in common use for determining the Sumner line:

(*a*) The Chord Method: To assume two values of one coordinate and find the corresponding values of the other. Two values of the latitude may be assumed and the longitudes determined, as was done by Capt. Sumner on the occasion that led to the discovery of his method; or else two values of the longitude may be assumed and the latitudes determined. Two points are fixed in this way, and the line joining them is the Sumner line.

(*b*) THE TANGENT METHOD: To assume either one latitude or one longitude and determine the corresponding coordinate. This gives one point of the Sumner line. The azimuth of the observed celestial body is then ascertained, and a line is drawn through the determined point at right angles to the direction in which the body bore at the time of the sight. This will be the Sumner line.

(*c*) In accordance with the method of Saint Hilaire, to be described in article 371, to lay off from an assumed geographical position, along the line of direction in which the body bore at the time of the sight, the determined distance to the Sumner line.

370. It follows that if the Sumner line be located by the first method and its direction thus defined, the azimuth of the observed body may be determined by finding the angle made by the line with the meridian and adding or subtracting 90°.

EXAMPLE: At sea, July 26, 1916, a. m., in Lat. 25° 12′ S., Long. 75° 30′ W., by D. R., observed an altitude of the planet Jupiter, east of the meridian, 32° 46′ 10″; watch time, $2^h 48^m 02^s$; C—W, $5^h 05^m 42^s$; C. C., + $2^m 18^s$; I. C., + 1′ 30″; height of eye, 18 feet. Required the Sumner line.

From a solution of this same problem for a single longitude (art. 343, Chap. XIII), the following were found: H. A. from Gr., $2^h 02^m 07^s$ W.; h, 32° 42′ 01″; p, 101° 37′ 18″. Assume values of Lat. 25° 02′ and 25° 22′ S.

h	32° 42′ 01″						
L_1	25 02 00	sec	.04284	L_2	25° 22′ 00″	sec	.04403
p	101 37 18	cosec	.00900			cosec	.00900
	2)159 21 19						
s_1	79 40 40	cos	9.25330	s_2	79 50 40	cos	9.24630
s_1-h	46 58 39	sin	9.86397	s_2-h	47 08 39	sin	9.86514
Gr. H. A.	$2^h 02^m 07^s$ W.		2)19.16911	Gr. H. A.	$2^h 02^m 07^s$		2)19.16447
H. A.$_1$	3 00 45 E.	sin ½ t_1	9.58455	H. A.$_2$	2 59 44	sin ½ t_2	9.58224
Long.$_1$	$5^h 02^m 52^s$ 75° 43′ 00″ W.			Long.$_2$	$5^h 01^m 51^s$ 75° 27′ 45″ W.		

A comparison of these results with those obtained by the solution with a single latitude shows that the hour angle, and consequently the longitude, corresponding to the latitude 25° 12′ S. are the means of those corresponding to the latitudes here used; and therefore that the assumption that the Sumner line is a straight line is accurate.

The line of the same sight might also have been found as follows:

Working with the single latitude 25° 12′ S., it was found that the corresponding longitude was 75° 35′ 30″ W. Now, by referring to an azimuth table or azimuth diagram, the azimuth corresponding to Lat. 25°.2 S., Dec., 11°.6 N., H. A., $3^h 00^m.2$ E. is S. 124° 30′ E.; therefore the Sumner line extends S. 34° 30′ E.

The line may therefore be defined in either of two ways, thus:

$$A_1\begin{cases}25° \; 02′ \; 00″ \text{ S.}\\ 75 \;\; 43 \;\; 00 \;\; \text{W.}\end{cases} \qquad A_2\begin{cases}25° \; 22′ \; 00″ \text{ S.}\\ 75 \;\; 27 \;\; 45 \;\; \text{W.}\end{cases}$$

Or, $A\begin{cases}25° \; 12′ \; 00″ \text{ S.}\\ 75 \;\; 35 \;\; 30 \;\; \text{W.}\end{cases}$ Line runs S. 34° 30′ E.

By inspection of the coordinates of A_1 and A_2 it may be seen that—

+20′ diff. lat. makes −15′.25 diff. long.; or
+20 miles diff. lat. makes −13.8 miles departure.

Therefore by reference to Table 2 it appears that the line runs about S. 34° 30′ E., and the azimuth of the body is S. 124° 30′ E.; thus the results obtained by the two methods agree.

Example: At sea, May 18, 1916, a. m., Lat. 41° 33′ N., Long. 33° 37′ W., by D. R., the mean of a series of observed altitudes of the sun's lower limb was 29° 41′ 00″; the mean watch time, $7^h\ 20^m\ 45^s.3$; C. C., $+4^m\ 59^s.2$; I. C., −30″; height of the eye, 23 feet; C−W, $2^h\ 17^m\ 06^s$. Required the Sumner line.

From a solution of this same problem for a single longitude (art. 343, Chap. XIII) the following were found: G. A. T., $21^h\ 46^m\ 35^s$; h, 29° 50′ 04″; p, 70° 28′ 42″. Assume values of the latitude 41° 03′ and 42° 03′ N.

h	29° 50′ 04″						
L_1	41 03 00	sec	.12255	L_2	42° 03′ 00″	sec	.12927
p	70 28 42	cosec	.02571			cosec	.02571
	2)141 21 46						
s_1	70 40 53	cos	9.51959	s_2	71 10 53	cos	9.50863
s_1-h	40 50 49	sin	9.81560	s_2-h	41 20 49	sin	9.81995
G. A. T.,	$21^h\ 46^m\ 35^s$		2)19.48345	G. A. T.	$21^h\ 46^m\ 35^s$		2)19.48356
L. A. T.$_1$	19 32 07	sin ½ t_1	9.74172	L. A. T.$_2$	19 32 05	sin ½ t_2	9.74178

Long.$_1$ $\left\{\begin{matrix} 2^h\ 14^m\ 28^s \\ 33°\ 37'\ 00'' \end{matrix}\right\}$W. Long.$_2$ $\left\{\begin{matrix} 2^h\ 14^m\ 30^s \\ 33°\ 37'\ 30'' \end{matrix}\right\}$W.

A$_1$ $\left\{\begin{matrix} 41°\ 03'\ 00''\ \text{N.} \\ 33\ \ 37\ \ 00\ \ \text{W.} \end{matrix}\right.$ A$_2$ $\left\{\begin{matrix} 42°\ 03'\ 00''\ \text{N.} \\ 33\ \ 37\ \ 30\ \ \text{W.} \end{matrix}\right.$ +60′ diff. lat. makes +0′.25 long.
+60 miles diff. lat. makes +0.2 mile departure.

Line runs, N. ¼° W. Azimuth, N. 89¾° E.

The same site worked with a single latitude, 41° 33′ N., as was done in the original example, with azimuth taken from tables or diagram, gives:

A $\left\{\begin{matrix} 41°\ 33'\ 00''\ \text{N.} \\ 33°\ 37'\ 16''\ \text{W.} \end{matrix}\right.$ Azimuth, N. 89° 45′ E.
Line runs, N. 0° 15′ W.

This example illustrates the case in which an observation is taken practically on the prime vertical; the azimuth shows the bearing to be within 0° 15′ of true East, and the Sumner line is therefore within 0° 15′ of the meridian; a variation of 30′ in either direction from the dead reckoning latitude makes a difference of only 7″.5 in the longitude.

Example: October 10, 1916, in Lat. 6° 20′ S. by account, Long. 30° 21′ 30″ W.; chro. time, $12^h\ 45^m\ 10^s$; observed altitude of moon's upper limb, 70° 15′ 30″, bearing north and east; I. C., −3′ 00″; height of eye, 26 feet; chro. fast of G. M. T., $1^m\ 37^s.5$. Required the Sumner line.

From a solution of the same problem with a single longitude (art. 332, Chap. XII), the following values are obtained: H. A. from Greenwich, $1^h\ 16^m\ 51^s$ W.; h, 70° 11′ 03″; d, 10° 03′ 00″ N. Assume the longitudes 30° 10′ and 30° 30′ W.

Gr. H. A.	$1^h\ 16^m\ 51^s$ W.	Gr. H. A.	$1^h\ 16^m\ 51^s$
Long.$_1$	2 00 40 W.	Long.$_2$	2 02 00
t_1	$0^h\ 43^m\ 49^s$ 10° 57′ 15″	t_2	$0^h\ 45^m\ 09^s$ 11° 17′ 15″

t_1	10° 57′ 15″	sec .00799		
d	10 03 00	tan 9.24853	cosec .75819	
h	70 11 03		sin 9.97349	A$_1$ 6° 29′ 33″ S. 30 10 00 W.
ϕ''_1	10 13 57 N.	tan 9.25652	sin 9.24955	
ϕ'_1	16 43 30 S.		cos 9.98123	
Lat.$_1$	6 29 33 S.			
t_2	11° 17′ 15″	sec .00848		
d	10 03 00	tan 9.24853	cosec .75819	
h	70 11 03		sin 9.97349	A$_2$ 6° 16′ 22″ S. 30 30 00 W.
ϕ''_2	10 14 38 N.	tan 9.25701	sin 9.25002	
ϕ'_2	16 31 00 S.		cos 9.98170	
Lat.$_2$	6 16 22 S.			

Working by the other method, and finding the azimuth, we have:

$$A\left\{\begin{array}{llll} 6^\circ & 21' & 39'' & \text{S.} \\ 30 & 21 & 30 & \text{W.} \end{array}\right. \qquad \text{Line runs N. } 55^\circ\ 50'\ \text{W.}$$

It might be shown that the results check with each other, as in previous cases.

Example: At sea, July 12, 1916, in Lat. 50° N., Long., 40° W., observed circum-meridian altitude of the sun's lower limb, the time by a chronometer regulated to Greenwich mean time being $2^h\ 41^m\ 39^s$; chro. corr., $-2^m\ 30^s$; I. C., $-3'\ 0''$; height of the eye, 15 feet. Find the Sumner line.

From the solution of the same problem for a single latitude (art. 330, Chap. XII) the following values were obtained: G. A. T., $2^h\ 33^m\ 45^s$; h, 61° 57′ 01″; d, 21° 58′ 38″ N.; a (Tab. 26), 2″.5. Assume longitudes 39° 45′ and 40° 15′ W.

Gr. H. A.	$2^h\ 33^m\ 45^s$	Gr. H. A.	$2^h\ 33^m\ 45^s$
Long.$_1$	$-\ 2\ \ 39\ \ 00$	Long.$_2$	$-\ 2\ \ 41\ \ 00$
t_1	5 15	t_2	7 15
h	61° 57′ 01″	h	61° 57′ 01″
at_1^2	+ 1 09	at_2^2	+ 2 11
H$_1$	61 58 10	H$_2$	61 59 12
z_1	28 01 50 N.	z_2	28 00 48 N.
d	21 58 38 N.	d	21 58 38 N.
L$_1$	50 00 28 N.	L$_2$	49 59 26 N.

The line given by these coordinates is then:

$$A_1\left\{\begin{array}{llll} 50^\circ & 00' & 28'' & \text{N.} \\ 39 & 45 & 00 & \text{W.} \end{array}\right. \qquad A_2\left\{\begin{array}{llll} 49^\circ & 59' & 26'' & \text{N.} \\ 40 & 15 & 00 & \text{W.} \end{array}\right.$$

This shows that the Sumner line lies so nearly in a due east-and-west direction that a difference of longitude of 30′ makes a difference of latitude of only 1′.

From the azimuth tables or diagram, it is found that the azimuth of the sun corresponding to Lat. 50° N. Dec. 22° N. and H. A. $6^m\ 15^s$ E., is N. 176° 55′ E. Therefore, using the values given by the earlier solution, the line is defined as follows:

$$A\left\{\begin{array}{llll} 49^\circ & 59' & 59'' & \text{N.} \\ 40 & 00 & 00 & \text{W.} \end{array}\right. \qquad \text{Line runs N. } 86^\circ\ 55'\ \text{E.}$$

The direction of the line thus given and of the one found from the double coordinates may be shown to agree as in examples before given.

THE METHOD OF SAINT HILAIRE OR OF THE CALCULATED ALTITUDES.

371. The foregoing parts of this work have set forth that, when the purpose of the navigator is to find the latitude, the observed celestial body should be situated on or near the meridian or at least not remote from it, and that he must apply different rules according as the body is on or near or more remote from the meridian; and again when his purpose is to find the longitude, the observed celestial body should be situated on or near or at least not remote from the prime vertical, and that he must then apply another set of rules. It is also explained in article 363 that a navigator, who has measured the altitude of a celestial body at a known instant of time, has really located his geographical position on the circumference of a circle whose radius is equal to the zenith distance (90° – Alt.) and whose center is the geographical position of the celestial body or that point on the earth's surface which falls vertically under the observed body at the instant of observation.

It has been pointed out that practical needs are concerned only with that portion of the circumference of the circle of position which lies in the vicinity of the estimated position of the ship, and, having seen how this portion may be determined and laid down by methods depending upon the computation of latitudes and longitudes, we proceed to extend our view to the accomplishment of this purpose by a method which is now rapidly growing in favor among practical navigators, because it brings the whole of astronomical navigation under a single rule by rendering the course of procedure the same, whatever the situation in the heavens of the observed body may be, provided only that the conditions admit of accurate measurement of its altitude.

In figure 54, the circumference of a circle of position is represented as having been laid down from A, the geographical position of the observed body, as a center, with a radius AC′ equal to the zenith distance of the observed celestial body; but it is evident that a small arc of the circumference, not differing sensibly from a straight line within the extent of a Sumner line, may be determined in the following manner from a neighboring geographical position, as at P, inside or outside of the circumference and at or near the position of the ship as given by dead reckoning:

1. Find the great-circle distance (zenith distance) and bearing (azimuth) of the geographical position of the observed body A from the observer's assumed position P.
2. Take the difference, in minutes of arc (nautical miles), between this zenith distance AP due to the observer's assumed position, and the zenith distance AC′ found from the true altitude resulting from observation.
3. Lay off this difference, which is called the altitude-difference, or intercept, from the assumed position P either away from or toward the observed celestial body according as the true altitude by observation is less or greater than the altitude at the assumed position, and through the point thus reached draw a line at right angles to the bearing.

The line so drawn will evidently be a tangent to the circumference of the circle of position, and will be so nearly coincident with this circumference throughout such length as the Sumner line need have, in all those cases in which the zenith distance is as great as 10°, that the tangent itself may be taken as the true line of position. Obviously the only trigonometrical computation that occurs under this method is in calculating the length and bearing of the great-circle arc joining the position P, which is assumed or known from the dead reckoning, with the geographical position A, which is always in a latitude equal to the declination of the observed celestial body at the instant of observation and in a longitude equal to the hour angle of the body from the prime meridian (Greenwich). In the case of the sun the Greenwich hour angle is expressed by Greenwich apparent time, and in the case of any other celestial body the Greenwich hour angle is found as explained in article 293, using G. M. T. instead of L. M. T.

372. Being strictly in the nature of calculating the great-circle distance and course between two points whose latitudes and longitudes are given, these computations may be made according to articles 190 and 191, Chapter V; but in practice it is unnecessary to do so, since various altitude and azimuth tables give the distance and azimuth or true bearing, on the globe or on the celestial sphere, of any place from every other place, and consequently the altitude and azimuth, or zenith distance and bearing, that any celestial body would have at any given time to an observer situated in any given geographical position. So that an observer in a geographical position as yet unknown, about to measure the altitude of a celestial body for the purpose of deducing geographical position, may assume beforehand a geographical position in the region of his station and find from the tables the altitude and azimuth which the celestial body would have if observed from the assumed position; and then, comparing the altitude so taken from the tables with the true altitude obtained by measurement, may at once find the Sumner line by laying off from the assumed geographical position along the direction of the bearing an intercept, called the altitude-difference, and drawing through its extremity a line at right angles to the bearing.

After finding the altitude-difference or intercept, the simplest procedure consists in laying it off on the chart from the assumed position and drawing the Sumner line through its extremity, but if, for any reason, this process is not desirable, the latitude and longitude of the extremity of the intercept, which is a point on the Sumner line, called the "computed point," may be found by the use of the Traverse Tables, or may be computed directly.

The exact position of the observer on the Sumner line is, of course, indeterminate from one observation, unless either the latitude or longitude of the observer's position be known beforehand, but the computed point will always be nearer to the actual position of the observer than the dead reckoning or assumed position is. To obtain a fix, that is, to find the actual position, it is necessary to determine the intersection of the first Sumner line with another line of position, which may be another Sumner line or a line of bearing or any other line containing the ship's position at the same time.

When the specially prepared altitude and azimuth tables are not preferred, the required azimuth or true bearing of the observed celestial body may be taken from the time azimuth tables, and the zenith distance, and hence the altitude, that the observed body would have at the instant of observation to an observer in the assumed geographical position may be conveniently computed by the following formula:

$$\text{hav } z = \text{hav } (L \sim d) + \cos L \cos d \text{ hav } t$$

or by the formula of haversines, which is rid of all doubt as to the algebraical signs of the quantities and requires reference to only one trigonometrical table:

$$\text{hav } z = \text{hav (Co. L} - \text{P. D.)} + \{\text{hav (Co. L} + \text{P. D.)} - \text{hav (Co. L} - \text{P. D.)}\} \text{hav } t$$

These are modifications of the fundamental formula:

$$\sin h = \sin L \sin d + \cos L \cos d \cos t,$$

which is itself often preferred for the computation of the altitude from the latitude, declination, and hour angle.

In the computations which follow, the parts of the several formulæ have been designated as follows:

IN THE COSINE-HAVERSINE FORMULA:

$$\left.\begin{array}{l} \text{hav } \theta = \cos L \cos d \text{ hav } t; \\ \text{hence,} \qquad \text{hav } z = \text{hav } (L \sim d) + \text{hav } \theta \end{array}\right\}$$

IN THE HAVERSINE FORMULA:

$$\text{hav A} = \text{hav (Co. L} + \text{P. D.)} - \text{hav (Co. L} - \text{P. D.)}$$

$$\text{hav B} = \{\text{hav (Co. L} + \text{P. D.)} - \text{hav (Co. L} - \text{P. D.)}\} \text{ hav } t;$$

hence,

$$\text{hav } z = \text{hav (Co. L} - \text{P. D.)} + \text{hav B}.$$

IN THE SINE-COSINE FORMULA:

$$\text{A} = \sin L \sin d, \quad \text{B} = \cos L \cos d \cos t;$$

hence,

$$\sin h = \text{A} + \text{B}.$$

EXAMPLE: At sea, May 18, 1916, a. m., Lat. 41° 33′ N.; Long. 33° 37′ W., by D. R., the mean of a series of observed altitudes of the sun's lower limb was 29° 41′ 00″; the mean watch time, $7^h\ 20^m\ 45.3^s$; C. C., $+4^m\ 59.2^s$; I. C., −30″; height of eye, 23 feet; C.−W., $2^h\ 17^m\ 06^s$. Required the Sumner line.

From a solution of the same problem under article 343, Chapter XIII, and article 370, Chapter XV, the following are taken from among the prepared data: G. A. T., $21^h\ 46^m\ 35^s$; P. D., 70° 28′ 42″; h, 29° 50′ 04″, and, therefore, the measured zenith distance (90°−h), 60° 09′ 56″.

Assume a position in latitude 41° 30′ N. and longitude 33° 38′ 45″ or $2^h\ 14^m\ 35^s$ W., then the solution will be as follows:

L.	41°	30′	00″	G. A. T.	21^h	46^m	35^s
				Long.	2	14	35 W.
Co. L.	48	30	00				
P. D.	70	28	42	L. A. T.	19	32	00 $=t$.

NOTE.—After obtaining the G. A. T., it will be seen that the longitude of the assumed position may be so chosen as to avoid seconds in the L. A. T. or H. A.

The azimuth found from the azimuth tables is N. 89° 45′ E.

BY THE COSINE-HAVERSINE FORMULA:

	t	$19^h\ 32^m\ 00^s$	log hav	9.48378
	L	41° 30′ 00″ N.	log cos	9.87446
	d	19° 31′ 18″ N.	log cos	9.97429
			log hav θ	9.33253[a]
			nat hav θ	0.21505
	L∼d	21° 58′ 42″..........	nat hav	0.03634
Calculated	z	60° 11′ 00″..........	nat hav	0.25139
		90° 00′ 00″		
Calculated	h	29 49 00		
Observed	h	29 50 04		
Altitude-difference		1′ 04″		

---

[a] The arrangement of Table 45 is such as to obviate the necessity of taking out the value of the angle in finding the natural haversine from the log. haversine, or vice versa.

BY THE HAVERSINE FORMULA:

Co. L+P. D.	118° 58′ 42″	nat hav	0. 74225
Co. L−P. D.	21 58 42	nat hav	0. 03634
nat hav A			0. 70591[a]
log hav A			9. 84876
log hav *t*			9. 48378
log hav B			9. 33254
nat hav B			0. 21505
nat hav (Co. L−P. D.)			0. 03634
nat hav *z*			0. 25139
Calculated *z*			60° 11′ 00″
			90 00 00
Calculated *h*			29 49 00
Observed *h*			29 50 04
Altitude-difference			1 04

BY THE SINE-COSINE FORMULA:

t	19ʰ 32ᵐ 00ˢ				
	293° 00′ 00″			log cos	9. 59188
L	41 30 00 N.	log sin	9. 82126	log cos	9. 87446
d	19 31 18 N.	log sin	9. 52396	log cos	9. 97429
		log A	9. 34522	log B	9. 44063
		A	0. 22142		
				B	0. 27581
				A	0. 22142
Calculated *h*=29° 49′ 00″		nat sin=A+B			0. 49723

Since the observed altitude is higher than the calculated altitude, the observer's position is nearer to the observed body than the assumed position. Consequently the altitude-difference should be laid off in a direction to the east and north, 89° 45′, 1.0 nautical mile from the assumed position.

Or, by the Traverse Tables:

Course.	Distance.	Diff. Lat.	Dep.	Diff. Long.
89° 45′	1.0	0′.0 N.	1′.0 E.	1′.3 E.

Assumed position, Lat.	41° 30′ 00″ N.	Long.	33° 38′ 45″ W.
Diff. Lat.	00 N.	Diff. Long.	1 18 E.
Computed point on Sumner line,	41° 30′ 00″ N.		33° 37′ 27″ W.

The direction of the Sumner line, being at right angles to the azimuth or true bearing of the observed celestial body, runs N. 0° 15′ W. and S. 0° 15′ E. or 359° 45′ and 179° 45′.

Example: At sea, October 10, 1916, in Lat. 6° 20′ S. by account, Long. 30° 21′ 30″ W.; chro. time, 12ʰ 45ᵐ 10ˢ; observed altitude of moon's upper limb, 70° 15′ 30″, bearing north and east; I. C., −3′ 00″; height of eye, 26 feet; chro. fast of G. M. T., 1ᵐ 37ˢ.5. Required the Sumner line.

From a solution of the same problem under article 332, Chapter XII, and again under article 370, Chapter XV, the following quantities are taken from among the prepared data: H. A. from Greenwich, 1ʰ 16ᵐ 51ˢ W.; corrected altitude, *h*, 70° 11′ 03″; *d*, 10° 03′ 00″ N. and, hence, P. D., 79° 57′ 00″.

Assume a position in Lat. 6° 00′ S. and Long. 30° 27′ 45″ W.; then the solution will be as follows:

L	6° 00′ 00″ S.	Gr. H. A.	1ʰ 16ᵐ 51ˢ W.
		Long.	2 01 51 W.
Co. L	96 00 00		
P. D.	79 57 00	*t*	0 45 00

---

[a] The arrangement of Table 45 is such as to obviate the necessity of taking out the value of the angle in finding the natural haversine from the log. haversine, or vice versa.

BY THE COSINE-HAVERSINE FORMULA:

t	$0^h\ 45^m\ 00^s$	log hav	7.98260
L	6° 00′ 00″ S.	log cos	9.99761
d	10 03 00 N.	log cos	9.99328
		log hav θ	7.97349
		nat hav θ	0.00941
L∼d	16° 03′ 00″	nat hav	0.01949
z	19 34 30	nat hav	0.02890
	90 00 00		
Calculated h	70 25 30		
Observed h	70 11 03		
Altitude-difference	14 27		

BY THE HAVERSINE FORMULA:

Co. L+P. D.	175° 57′ 00″	nat hav	0.99875
Co. L−P. D.	16 03 00	nat hav	0.01949
nat hav A			0.97926
log hav A			9.99090
log hav t			7.98260
log hav B			7.97350
nat hav B			0.00941
nat hav (Co. L−P. D.)			0.01949
nat hav z			0.02890
Calculated z			19° 34′ 30″
			90 00 00
Calculated h			70 25 30
Observed h			70 11 03
Altitude-difference			14 27

BY THE SINE-COSINE FORMULA:

t	$0^h\ 45^m\ 00^s$				
	11° 15′ 00″..........................			log cos	9.99157
L	6 00 00 S.	log sin	9.01923—	log cos	9.99761
d	10 03 00 N.	log sin	9.24181	log cos	9.99328
		log A	8.26104—	log B	9.98246
		A	=−0.01824	B	= 0.96044
				A	=−0.01824

Calculated h=70° 25′ 30″ nat. sin=A+B 0.94220

The azimuth from the Azimuth Tables S. 145° 50′ E. or N. 34° 10′ E.

Since the observed altitude is lower than the calculated altitude, the observer's position is further removed from the observed body than the assumed position. Consequently the altitude-difference should be laid off to the south and west, 214° 14.4 nautical miles from the assumed position.

Or, by the Traverse Tables:

Course.	Distance.	Diff. Lat.	Dep.	Diff. Long.
214°	14.4	11′.9 S.	8′.0 W.	8′.0 W.

Assumed position, Lat.	6° 00′ 00″ S.	Long.	30° 27′ 45″ W.
Diff. Lat.	11 54 S.	Diff. Long.	8 00 W.
Computed point on Sumner line,	6 11 54 S.		30 35 45 W.

The direction of the Sumner line, being at right angles to the azimuth or true bearing of the observed body, is N. 55° 50′ W. and S. 55° 50′ E., or 304° 10′ and 124° 10′.

Example: At sea, July 12, 1916, in Lat. 50° N., Long. 40° W., observed an ex-meridian altitude of the sun's lower limb, 61° 48′ 30″, the time by chronometer regulated to Greenwich mean time being $2^h\ 41^m\ 39^s$; chro. corr., $-2^m\ 30^s$; I. C., −3′ 00″; height of eye, 15 feet. Find the Sumner line.

From a solution of the same problem under article 330, Chapter XII, and again under article 370, Chapter XV, the following quantities are taken from among the prepared data: G. A. T., $2^h\ 33^m\ 45^s$; *h*, 61° 57′ 01″; *d*, 21° 58′ 38″ N.

Assume a position in Lat. 49° 50′ N., Long. 40° 11′ 15″ or $2^h\ 40^m\ 45^s$ W., then the solution will be as follows:

L.	49° 50′ 00″ N.	G. A. T.	$2^h\ 33^m\ 45^s$	*d*	21° 58′ 38″ N.
		Long.	2 40 45 W.		
Co. L	40 10 00			P. D.	68 01 22
P. D.	68 01 22	L. A. T=*t*	0 07 00 E.		

BY COSINE-HAVERSINE FORMULA:

t	$0^h\ 7^m\ 00^s$	log hav	6. 36774
L	49° 50′ 00″ N.	log cos	9. 80957
d	21° 58′ 38″ N.	log cos	9. 96724
		log hav *θ*	6. 14455
		nat hav *θ*	0. 00014
L∼*d*	27° 51′ 22″	nat hav	0. 05793
z	27° 53′ 15″	nat hav	0. 05807
	90° 00′ 00″		
Calculated *h*	62 06 45		
Observed *h*	61 57 01		
Altitude-difference	9 44		

BY HAVERSINE FORMULA:

Co. L+P. D.	108° 11′ 22″	nat hav	0. 65607
Co. L−P. D.	28 11 22	nat hav	0. 05793
nat hav A			0. 59814
log hav A			9. 77681
log hav *t*			6. 36774
log hav B			6. 14455
nat hav B			0. 00014
nat hav (Co. L−P. D.)			0. 05793
nat hav *z*			0. 05807
Calculated *z*		27° 53′ 15″	
		90 00 00	
Calculated *h*		62 06 45	
Observed *h*		61 57 01	
Altitude-difference		9 44	

BY THE SINE-COSINE FORMULA:

t	$0^h\ 07^m\ 00^s$				
	1° 45′ 00″			log cos	9. 99980
L	49 50 00 N.	log sin	9. 88319	log cos	9. 80957
d	21 58 38 N.	log sin	9. 57315	log cos	9. 96724
		log A	9. 45634	log B	9. 77661
		A	0. 28598	B	0. 59787
				A	0. 28598
Calculated *h*=62° 06′ 37″		nat sin	=	A+B	0. 88385

The azimuth from the Azimuth Tables: N. 177° E. or S. 3° E.

Since the observed altitude is lower than the calculated altitude, the observer's position is farther removed from the observed body than the assumed position. Consequently the altitude-difference should be laid off to the north and west, 357°, 9.7 nautical miles from the assumed position.

Or, by the Traverse Tables:

Course.	Distance.	Diff. Lat.	Dep.	Diff. Long.
357°	9.7	9.7 N.	0′.5 W.	0′.78 W.

Assumed position, Lat.	49°	50′	00″	N.	Long.	40°	11′	15″	W.
Diff. Lat.		9	42	N.	Diff. Long.		0	46	W.
Computed point of Sumner line	49	59	42	N.		40	12	01	W.

The direction of the Sumner line, being at right angles to the azimuth or true bearing of the observed body, is N. 87° E. and S. 87° W., or 87° and 267°.

373. In the first of the three foregoing examples, the observed celestial body is represented as being near the prime vertical; in the second, remote from both the prime vertical and the meridian; and in the third, near the meridian. These examples have been solved in the preceding chapters by three different methods known, respectively, as the time sight, the ϕ' ϕ'', and the ex-meridian; but we have here treated all of them by one method, and have determined Sumner lines which are in agreement with those determined by the various preceding methods. And it would be likewise if we should take examples in which meridian altitudes have been observed. Inasmuch as the local hour angle of a celestial body is 0° at the time of its passage across the meridian of an observer, the second member of the right-hand side of the equation of haversines becomes zero in cases in which the meridian altitude has been observed, since the haversine of 0° is equal to zero. The equation therefore reduces to

$$\text{hav } z = \text{hav (Co. L} - \text{P. D.)}$$

or

$$z = (\text{Co. L} - \text{P. D.})$$

which leads at once to the usual formulae given in article 321, Chapter XII, for finding the latitude from a meridian altitude. By this we are taught the full interpretation of a meridian altitude, which is that it gives the latitude of the intersection with the local meridian of a Sumner line coinciding with a parallel of latitude.

374. In addition to the simplicity which arises from always working by the same rule, the navigator has, by this method, the further practical advantage of being able to do the most of the work of obtaining the Sumner line before taking the observation, since, in clear weather, he may, in selecting the assumed geographical position, assume an hour angle and calculate what time the chronometer or watch ought to show at the instant when the celestial body has this hour angle, and then observe the altitude at this instant; or, if anything should happen to make him a few seconds late in getting the altitude, he may alter the assumed longitude by a corresponding amount so as to make the hour angle right, and then the rest of the work will hold good.

After correcting the observed altitude and obtaining from it the true altitude, no more time need subsequently elapse in determining the Sumner line than is necessary to take the difference between the altitudes found by calculation and by observation and to rule a line at right angles to the bearing of the observed body through the point found by laying off this altitude-difference as an intercept from the assumed position.

375. It has already been remarked that the labor of performing such computations as the foregoing may be saved when a book of altitude and azimuth tables is at hand. These tables are arranged to be entered with the hour angle, the declination, and the latitude; and they contain the corresponding values of the altitude and azimuth. In the various books containing such tables, the special rules to be observed in their use are set forth.

It has been implied that when the altitude of the observed body is greater than 80° and, therefore, the zenith distance or radius of the circle of position is less than 10°, the tangent drawn to the circumference to represent the Sumner line could no longer be regarded as coinciding throughout its proper length with the arc of the circumference. When the zenith distance is 10°, the departure of the tangent from the circumference is one-tenth of a mile at a distance of 10 miles from the theoretical point of tangency and seven-tenths of a mile at a distance of 30 miles from the theoretical point of tangency. These departures are doubled when the zenith distance is reduced to 5°, and they are nearly ten times the amounts stated for 10° when the zenith distance is shortened to 1°.

There is not, however, any occasion for resorting to the proceeding of laying down a straight line as a substitute for an arc of the actual circle of position when the zenith distance is only a few degrees in length. In such cases the greatest convenience and the best results are found by drawing circles of position directly on the navigator's chart. For this purpose the polyconic chart, being issued to navigators throughout all latitudes from 20° to 60° north of the Equator in connection with the works of the United States Coast and Geodetic Survey, and therefore being available throughout a like extent of south latitude by mere inversion, is generally serviceable, because a chart embracing any certain parallels of latitude is available between these parallels of latitude throughout all longitudes; and the Mercator projection may also be used for this purpose within the Tropics, since the length of a minute of latitude as represented on this projection varies but little within tropical limits. For instance, it happens in crossing the tropical zone that, for a day or so, the sun is very near the zenith—perhaps not more than 1° away on one day and 2° or 3° on another. In such circumstances, having a chart of suitable scale embracing the parallels of latitude of the region in which the ship is situated, plot the sun's geographical position with Greenwich hour angle as longitude and declination as latitude, take on the dividers the zenith distance, or complement of the corrected altitude, and draw in a portion of the circumference of the actual circle of position lying near the position of the ship as given by dead reckoning. Then wait until the azimuth has changed 30° or so—which it does very rapidly near noon—and draw a second similar arc. The intersection of these arcs gives the ship's position with accuracy. Of course if the ship has moved in geographical place in the interval between the two sights, it will be necessary, in order to find the geographical position at the instant of the second sight, to move the first circle of position in direction and amount equal to the course and distance made good in the interval.

FINDING THE INTERSECTION OF SUMNER LINES.

376. The intersection of Sumner lines may be found either graphically or by computation.

(*a*) Graphic methods.—Each line may be plotted upon the chart of the locality in which the ship is being navigated, in accordance with the data for its determination (see art. 367), and the intersection thus found. This plan will commend itself especially when the vessel is near shore, as the chart in use will then probably be one of large enough scale, and it will be an advantage to see where the Sumner lines fall with reference to the soundings and landmarks. To aid the extension of this convenient practice on the ocean, where the navigator is usually furnished only with a general chart, position-line plotting sheets have been provided for the use of navigators upon an ample scale.

(*b*) Methods by Computation.—The finding of the intersection of two Sumner lines by computation may be divided into two cases:

Case I. When one line lies in a NE.-SW. direction, and the other in a NW.-SE. direction, as shown in figure 56.

Case II. When both lie in a NE.-SW., or both in a NW.-SE. direction, as shown in figure 57.

377. If each Sumner line is defined by the latitude and longitude of one of its points and the azimuth of the celestial body at right angles to whose true bearing the line runs, we may then, by means of Table 47, find the longitude of any other point on such a line when its difference of latitude from the known point has been ascertained. The numbers in Table 47 are values of the longitude factor, usually denoted by the letter F. They vary with the latitude of the observer and the celestial body's azimuth at right angles to the direction of the line, and express the change in longitude due to a change of 1′ in latitude along any given Sumner line. So that the difference of latitude between any two points of a line, being multiplied by the longitude factor, will give the difference of longitude between those points.

Turning to figures 56 and 57 and considering the Sumner lines $A_1 A_2$ and $B_1 B_2$ there represented to be defined by the azimuth at right angles to each and the latitudes and longitudes of the points A_1 and B_1, respectively, we proceed to show the relations which exist for determining the latitude and longitude of the fix at their intersection by means of the tabulated longitude factors. The line PO being drawn perpendicular to the parallel of latitude through the points A_1 and B_1, the latitude of the intersection will be a distance OP from the common latitude of A_1 and B_1, and its longitude will be a distance $A_1 O$ from A_1 and $B_1 O$ from B_1. Let F_1 and F_2 represent the longitude factors from Table 47 for the Sumner lines $A_1 A_2$ and $B_1 B_2$, respectively. Then, since F_1 is the difference of longitude corresponding to a change of 1′ of latitude along the line $A_1 A_2$, the difference of longitude $A_1 O$ must be equal to F_1 multiplied into the number of minutes of latitude in the length OP. Therefore,

$$A_1 O = OP \times F_1,$$

and likewise

$$B_1 O = OP \times F_2;$$

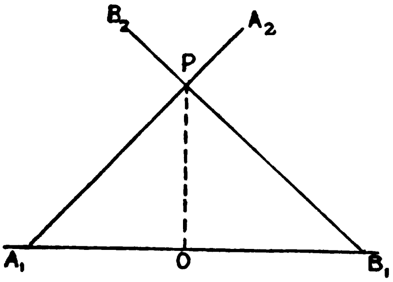

Fig. 56.

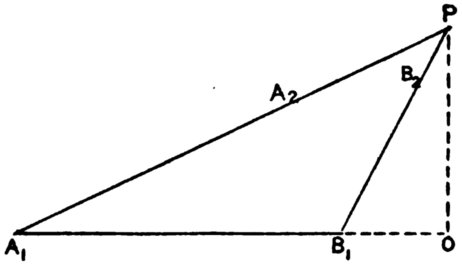

Fig. 57.

and, since the known difference of longitude between the points A_1 and B_1 is composed of the sum of $A_1 O$ and $B_1 O$ in Case I, and the difference of $A_1 O$ and $B_1 O$ in Case II, we have

$$A_1 O + B_1 O = A_1 B_1 = OP \times F_1 + OP \times F_2 = OP\ (F_1 + F_2), \text{ in Case I, and}$$
$$A_1 O - B_1 O = A_1 B_1 = OP \times F_1 - OP \times F_2 = OP\ (F_1 - F_2), \text{ in Case II.}$$

From which, placing the known quantities on the right-hand side of the equations, thus:

$$OP = \frac{A_1 B_1}{F_1 + F_2}, \text{ in Case I, and}$$

$$OP = \frac{A_1 B_1}{F_1 - F_2}, \text{ in Case II.}$$

Hence, we obtain the difference of latitude from the common parallel of A_1 and B_1 to the point of intersection by dividing the known difference of longitude between the points A_1 and B_1 by the sum of the longitude factors of the respective Sumner lines in Case I, and by their difference in Case II.

Having determined OP and hence the latitude of the point of intersection of the Sumner line, we proceed to multiply OP by F_1 to get the difference of longitude A_1O, and apply that difference to the known longitude of A_1 to find the longitude of the point of intersection P; and also, as a check, to multiply OP by F_2 to get the difference of longitude B_1O, which, being applied to the longitude of B_1, gives again the longitude of the point of intersection, P.

The following is a summary of the successive steps to be taken in following this method:

1. Make a rough sketch of the Sumner lines whose intersection is to be fixed in latitude and longitude, classifying them under Case I or Case II.

2. Take from Table 47 the longitude factors F_1 and F_2, respectively, for the Sumner lines.

3. If the given coordinates of the points on the two lines have not a common latitude, reduce them to a common latitude by multiplying the difference between the latitudes of the points on the two lines by the longitude factor of one of the lines and applying the product to the longitude of the point on that line. The sketch will show whether the difference of longitude is to be added or subtracted, and the result will be the longitude of a point of this line on the common parallel of latitude.

4. The difference between the longitudes of the points of the two Sumner lines, on the common parallel, divided by the sum of the longitude factors (F_1+F_2), will give the difference of latitude between the point of intersection and the common parallel, when the lines are classified under Case I; and the difference between the longitudes of the points of the two Sumner lines, on the common parallel, divided by the difference of the longitude factors (F_1-F_2), will give the difference of latitude between the point of intersection and the common parallel, when the lines are classified under Case II.

The sketch will show whether the intersection of the Sumner lines lies to the northward or southward of the common parallel, and hence whether the difference of latitude is to be added to or subtracted from the latitude of the common parallel.

5. Having found the difference of latitude between the point of intersection of the Sumner lines and the common parallel, multiply this difference by the longitude factor of each line and apply the products each to the longitude of its corresponding line on the common parallel. The products are applied in opposite directions in Case I, and both of them must lead to the same longitude for the point of intersection; and the products are applied in the same direction in Case II, and in this case also both of them must lead to the same longitude for the point of intersection.

Example: Find the intersection of the Sumner lines defined below by the latitude and longitude of a single point on each and by the respective azimuths of the celestial bodies upon which the lines depend.

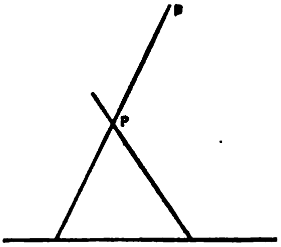

Fig. 58.

$A\left\{\begin{matrix}25^\circ\ 40'\ S.\\ 115^\circ\ 31'\ W.\end{matrix}\right\}$ Azimuth, at right angles to line, N. 51° E.

$B\left\{\begin{matrix}25^\circ\ 25'\ S.\\ 115^\circ\ 33'.5\ W.\end{matrix}\right\}$ Azimuth, at right angles to line, N. 72° W.

From Table 47:

Longitude factor for line A=0.90=F_1.
Longitude factor for line B=0.36=F_2.

Reduce the given points to a common parallel of latitude by transferring the point on line B to the latitude of the point on line A,

$$\begin{array}{lr}(25^\circ\ 40'\ S.-25^\circ\ 25'\ S.)\times F_2=15'\times 0.36= & 5'.4\ W.\\ & 115^\circ\ 33'.5\ W.\\ \hline & 115^\circ\ 38'.9\ W.\end{array}$$

Hence we have for the point on the line B at which the latitude is the same as the latitude of the point on the line A,

$B\left\{\begin{matrix}25^\circ\ 40'\ S.\\ 115^\circ\ 38'.9\ W.\end{matrix}\right\}$ Azimuth, at right angles to line, N. 72° W.

We now have two Sumner lines, under Case I, whose common latitude is 25° 40′ S. and whose longitudes on the common parallel are:

$$\begin{array}{l}115^\circ\ 38'.9\ W.\\ 115^\circ\ 31'.0\ W.\\ \hline 7'.9=\text{Diff. Long. on common parallel.}\end{array}$$

$\frac{7.9}{F_1+F_2}=\frac{7.9}{.90+.36}=\frac{7.9}{1.26}=6.27$ Diff. Lat. between intersection and common parallel.

Corrections in longitude:

$$6.27 \times F_1 = 6.27 \times 0.90 = 5'.64$$
$$6.27 \times F_2 = 6.27 \times 0.36 = 2.26$$

Long. A	115° 31′.00 W.	Long. B	115° 38′.90 W.	Lat. common parallel	25° 40′.00 S.
Diff. Long.	5 .64 W.	Diff. Long.	·2 .26 E.	Diff. Lat.	6 .27 N.
Intersection	115 36 .64 W.		115 36 .64 W.		25 33 .73 S.

Example: Find the intersection of the Sumner lines defined below:

$$A\left\{\begin{array}{llll}49^\circ & 30' & & \text{N.}\\ 5 & 24 & .8 & \text{W.}\end{array}\right\} \text{ Azimuth, at right angles to line, N. } 81^\circ \text{ W.}$$
$$B\left\{\begin{array}{llll}49^\circ & 30' & & \text{N.}\\ 5 & 25 & .8 & \text{W.}\end{array}\right\} \text{ Azimuth, at right angles to line, N. } 31^\circ \text{ W.}$$

A sketch of the lines shows their classification to be under Case II.

From Table 47:

Longitude factor for line A$=0.24=F_1$.
Longitude factor for line B$=2.57=F_2$.

Diff. Long. on common parallel$=5^\circ\ 25'.8 - 5^\circ\ 24'.8 = 1'.0$.

$$\frac{1.0}{F_2-F_1}=\frac{1.0}{2.57-0.24}=\frac{1.0}{2.33}=0.429$$ =Diff. Lat. between intersection and common parallel.

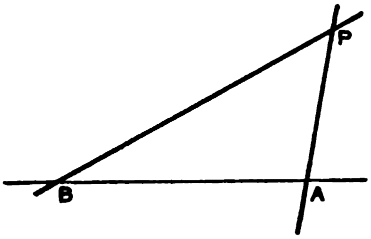

FIG. 59.

Corrections in longitude:

$$0.429 \times F_1 = 0.429 \times 0.24 = 0.10.$$
$$0.429 \times F_2 = 0.429 \times 2.57 = 1.10.$$

Long. A	5° 24′ .8 W.	Long. B	5° 25′ .8 W.	Lat. common parallel	49° 30′ .0 N.
Diff. Long.	0 .1 E.	Diff. Long.	1 .1 E.	Diff. Lat.	0 .4 N.
Intersection	5 24 .7 W.		5 24 .7 W.		49 30 .4 N.

378. If the two geographical positions defining two Sumner lines have a common longitude instead of a common latitude, as represented in figures 60 and 61, their intersection may be found by means of the latitude factors tabulated in Table 48, in a manner similar to the use of the longitude factors in connection with the Sumner lines whose known points have a common latitude. The latitude factors vary with the latitude of the observer and the celestial body's azimuth at right angles to the direction of the line, and express the change in latitude due to a change of 1′ in longitude along any given Sumner line. So that the difference of longitude between any two points of a line being multiplied by the latitude factor will give the difference of latitude between those points.

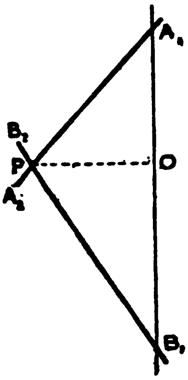

FIG. 60.

The latitude factors of two Sumner lines whose intersection is to be found are usually denoted by the letters f_1 and f_2, and the successive steps to be taken in finding the intersection are here summarized:

1. Make a rough sketch of the Sumner lines whose intersection is to be fixed in latitude and longitude, classifying them under Case I or Case II.
2. Take from Table 48 the latitude factors f_1 and f_2, respectively, for the Sumner lines.
3. The difference between the latitudes of the points of the two Sumner lines, in the common longitude, divided by the sum of the latitude factors (f_1+f_2), will give the difference of longitude between the point of intersection and the common meridian when the lines are classified under Case I; and the difference between the latitudes of the

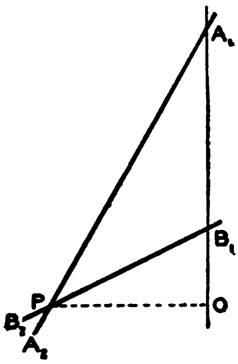

FIG. 61.

points of the two Sumner lines, in the common longitude, divided by the difference of the latitude factors $(f_1 - f_2)$, will give the difference of longitude between the point of intersection and the common meridian when the lines are classified under Case II.

The sketch will show whether the intersection of the Sumner lines lies to the eastward or westward of the common meridian, and hence whether the difference of longitude is to be added to or subtracted from the common longitude.

4. Having found the difference of longitude between the point of intersection of the Sumner lines and the common longitude, multiply this difference by the latitude factor of each line and apply the products each to the latitude of its corresponding line on the common meridian. The products are applied in opposite directions in Case I, and both of them must lead to the same latitude for the point of intersection; and the products are applied in the same direction in Case II, and in this case also both of them must lead to the same latitude for the point of intersection.

Example: Find the intersection of the Sumner lines defined below:

$$A\begin{cases}40^\circ\ 13'.55\text{ N.}\\ 71\ \ 14\ .86\text{ W.}\end{cases}\quad \text{Azimuth, at right angles to line, N. }57^\circ.6\text{ W.}$$

$$B\begin{cases}40^\circ\ 06'.40\text{ N.}\\ 71\ \ 14\ .86\text{ W.}\end{cases}\quad \text{Azimuth, at right angles to line, N. }77^\circ\text{ W.}$$

A sketch of the lines shows their classification to be under Case II.

From Table 48:

Latitude factor for line A = 1.23 = f_1.
Latitude factor for line B = 3.32 = f_2.

Diff. Lat. on common meridian = 7′.15.

$$\frac{7.15}{f_2-f_1}=\frac{7.15}{3.32-1.23}=\frac{7.15}{2.09}=3'.42\quad\text{Diff. Long. between intersection and common meridian.}$$

Corrections in latitude:

$$3.42\times f_1=3.42\times 1.23=\ 4'.20$$
$$3.42\times f_2=3.42\times 3.32=11.35$$

Lat. A	40° 13′. 55 N.	Lat. B	40° 06′. 40 N.	Long. on common meridian	71° 14′. 86 W.
Diff. Lat.	4 . 20 N.	Diff. Lat.	11 . 35 N.	Diff. Long.	3. 42 E.
Intersection	40° 17′. 75 N.		40° 17′. 75 N.		71° 11′. 44 W.

379. When a Sumner line is defined by the latitudes and longitudes of two of its points, the longitude factor for the line may be found by dividing the difference between the longitudes of the two given points by the difference between their latitudes; and the latitude factor, being the reciprocal of the longitude factor, may be found by dividing the difference between the latitudes of the two given points by their difference of longitude.

The method of finding the intersection of Sumner lines by longitude and latitude factors, described in articles 377 and 378, may, therefore, be applied as well when the lines are defined by pairs of geographical positions as when they are defined by the azimuth and one geographical position.

380. The modification of the methods for finding the intersection of two Sumner lines, where there is a run between the observations from which they are deduced, will be readily apparent. It is known that at the time of taking a sight the vessel is at one of the points of the Sumner line, but which of the various points represents her precise position must remain in doubt until further data are acquired. Suppose, now, that after an observation, the vessel sails a given distance in a given direction; it is clear that while her exact position is still undetermined it must be at one of the series of points comprised in a line parallel to the Sumner line and at a distance and direction therefrom corresponding to the course and distance made good; hence, if a second sight is then taken, the position of the vessel may be found from the intersection of two lines—one, the Sumner line given by the second observation, and the other a line parallel to the first Sumner line but removed from it by the amount of the intervening run.

Positions may be brought forward graphically on a chart by taking the course from the compass rose with parallel rulers, and the distance by scale with dividers. If one of the methods by computation be adopted, the point or points of the first line are brought forward by the traverse tables, using middle latitude sailing. The direction of a Sumner line as determined from the azimuth of the body always remains the same, whatever shift may be made in the position of the point by which the line is further defined.

Example: Taking the Sumner lines, which are defined in the first example under article 377, by the latitude and longitude of a point of each and by the respective azimuths of the celestial bodies upon which the lines depend, as follows:

$$A\left\{\begin{array}{lll}25^\circ & 40' & \text{S.}\\ 115 & 31 & \text{W.}\end{array}\right\}\text{Azimuth, at right angles to line, N. }51^\circ\text{ E.}$$

$$B\left\{\begin{array}{lll}25^\circ & 25' & \text{S.}\\ 115 & 33\ .5 & \text{W.}\end{array}\right\}\text{Azimuth, at right angles to line, N. }72^\circ\text{ W.}$$

and supposing the vessel from which the observations were taken that gave these lines to have run N. 54° E. (true) 35 miles in the interval between the sights, find the position of the vessel at the time of the second sight.

The point A, in 25° 40′ S. and 115° 31′ W., is first transferred to the point A′, 35 miles N. 54° E.(true) from A, by the method of Middle Latitude Sailing (article 177) by means of the Traverse Tables, thus:

From Table 2, course N. 54° E.; Dist., 35 miles; we find Diff. Lat. 20.6 N., Dep. 28.3 E. Therefore,

$$\begin{array}{lrrl}\text{Lat. A} & 25^\circ & 40' & \text{S.}\\ \text{Diff. Lat.} & & 20\ .6 & \text{N.}\\ \hline \text{Lat. A}' & 25 & 19\ .4 & \text{S.}\end{array}\qquad\qquad \begin{array}{lrrl}\text{Lat. A} & 25^\circ & 40' & \text{S.}\\ \text{Lat. A}' & 25 & 19\ .4 & \text{S.}\\ \hline & 2)50 & 59\ .4 & \\ \hline \text{Middle Lat.} & 25 & 29\ .7 & \end{array}$$

From Table 2, Middle Lat. (course), 25½°, Dep. (Lat.), 28.3 E., we find Diff. Long. (Dist.), 31.3 E. Therefore,

$$\begin{array}{lrrl}\text{Longitude A,} & 115^\circ & 31' & \text{W.}\\ \text{Diff. Long.} & & 31\ .3 & \text{E.}\\ \hline \text{Longitude A}', & 114 & 59\ .7 & \text{W.}\end{array}$$

The Sumner lines whose intersection is to be found are therefore defined as follows:

$$A'\left\{\begin{array}{lll}25^\circ & 19'.4 & \text{S.}\\ 114 & 59\ .7 & \text{W.}\end{array}\right\}\text{Azimuth, at right angles to the line, N. }51^\circ\text{ E.}$$

$$B\left\{\begin{array}{lll}25^\circ & 25' & \text{S.}\\ 115 & 33\ .5 & \text{W.}\end{array}\right\}\text{Azimuth, at right angles to the line, N. }72^\circ\text{ W.}$$

From Table 47:

$$\text{Longitude factor for line A}'=0.90=F_1$$
$$\text{Longitude factor for line B }=0.36=F_2$$

Reduce the given points to a common parallel of latitude by transferring the point on line B to the latitude of the point on line A′,

$$\begin{array}{lrrl}(25^\circ\ 19'.4\ \text{S.}-25^\circ\ 25'\ \text{S.})\times F_2=-5.6\times0.36= & & 2'.0 & \text{E.}\\ & 115^\circ & 33\ .5 & \text{W.}\\ \hline & 115 & 31\ .5 & \text{W.}\end{array}$$

Hence we have for the point on the line B at which the latitude is the same as the latitude of the point on the line A′,

$$B'\left\{\begin{array}{ll}25^\circ & 19'.4\ \text{S.}\\ 115 & 31\ .5\ \text{W.}\end{array}\right.$$

We now have two Sumner lines, A′ and B′, under Case I, whose common latitude is 25° 19′.4 S., and whose longitudes on the common parallel are 114° 59′.7 and 115° 31′.5. Hence, the difference of longitude on the common parallel is

$$\begin{array}{l} 115^\circ\ 31'.5\text{ W.} \\ 114^\circ\ 59'.7\text{ W.} \\ \hline \quad\ \ 31\ .8 = \text{Diff. Long. on common parallel.} \end{array}$$

$$\frac{31.8}{F_1+F_2}=\frac{31.8}{0.90+0.36}=\frac{31.8}{1.26}=25.2=\text{Diff. Lat. between intersection and common parallel.}$$

Corrections in longitude:

$$25.2\times F_1=25.2\times 0.90=22.7$$
$$25.2\times F_2=25.2\times 0.36=\ 9.1$$

Long. A′	114° 59′.7 W.	Long. B′	115° 31′.5 W.	Lat. common par.	25° 19′.4 S.
Diff. Long.	22 .7 W.	Diff. Long.	9.1 E.	Diff. Lat.	25 .2 N.
Intersection	115 22 .4 W.		115 22 .4		24 54 .2 S.

CHAPTER XVI.

THE PRACTICE OF NAVIGATION AT SEA.

381. Having set forth in previous chapters the methods of working dead reckoning and of solving problems to find the latitude, longitude, chronometer correction, and azimuth from astronomical observations, it will be the aim of the present chapter to describe the conditions which govern the choice and employment of the various problems, together with certain considerations by which the navigator may be guided in his practical work at sea.

382. Departure and Dead Reckoning.—On beginning a voyage, a good departure must be taken while landmarks are still in view and favorably located for the purpose; this becomes the origin of the dead reckoning, which, with frequent new departures from positions by observation, is kept up to the completion of the voyage, thus enabling the mariner to know, with a fair degree of accuracy, the position of his vessel at any instant.

At the moment of taking the departure, the reading of the patent log (which should have been put over at least long enough previously to be regularly running) must be recorded, and thereafter at the time of taking each sight and at every other time when a position is required for any purpose, the log reading must also be noted. It is likewise well to read the log each hour, for general information as to the speed of the vessel as well as to observe that it is in proper running order and that the rotator has not been fouled by seaweed or by refuse thrown overboard from the ship. It is a good plan to record the time by ship's clock on each occasion that the log is read, as a supplementary means of arriving at the distance will thus be available in case of doubt. If a vessel does not use the patent log but estimates her speed by the number of revolutions of the engines or the indications of the chip log, the noting of the time becomes essential. A good sight is of no value unless one knows the point in the ship's run at which it was taken, so that the position it gave may be brought forward with accuracy to any later time.

383. General Description of the Day's Work.—The routine of a day's work at sea consists in working the dead reckoning, an a. m. time sight and azimuth taken when the sun is in its most favorable position for the purpose, a meridian altitude of the sun (or, when clouds interfere at noon, a sight for latitude as near the meridian as possible), and a p. m. time sight and azimuth. This represents the minimum of work, and it may be amplified as circumstances render expedient; but no part of it should ever be omitted unless cloudy weather renders its performance impossible.

384. Morning Sights.—The morning time sight and azimuth should be observed, if possible, when the sun is on the prime vertical. As the body bears east at that time, the resulting Sumner line is due north and south, and the longitude will thus be obtained without an accurate knowledge of the latitude. Another reason for so choosing the time is that near this point of the sun's apparent path the body is changing most slowly in azimuth, and an error in noting the time will have the minimum effect in its computed bearing. The time when the sun will be on the prime vertical—that is, when its azimuth is 90°—may be found from the azimuth tables or the azimuth diagram. Speaking generally, during half the year the sun does not rise until after having crossed the prime vertical, and is therefore never visible on a bearing of east. In this case it is best to take the observation as soon as it has risen above the altitude of uncertain atmospheric effects—between 10° and 15°.

A series of several altitudes should be taken, partly because the mean is more accurate than a single sight, and partly because an error in the reading of the watch or sextant may easily occur when there is no repetition. If the sextant is set in advance of the altitude on even five or ten minute divisions of the arc, and the time marked at contacts, the method will be found to possess various advantages. As the sight is being taken the patent log should be read and ship's time recorded. It is well, too, to make a practice of noting the index correction of the sextant each time that the sextant is used. The bearing of the sun by compass should immediately afterward be observed, and the heading by compass noted, as also the time (by the same watch as was used for the sight).

Before working out the sight, the dead reckoning is brought up to the time of observation, and the latitude thus found used as the approximate latitude at sight. It is strongly recommended that *every sight be worked for a Sumner line,* either by assuming two latitudes, or by using one latitude and the azimuth, or yet more advantageously by the method of Saint Hilaire.

The compass error is next obtained. From the time sight the navigator learns that his watch is a certain amount fast or slow of L. A. T., and he need only apply this correction to the watch time of azimuth to obtain the L. A. T. at which it was observed; then he ascertains the sun's true bearing from the azimuth tables or azimuth diagram, compares it with the compass bearing, and obtains the compass error; he should subtract the variation by chart and note if the remainder, the deviation, agrees with that given in his deviation table; but in working the next dead reckoning, if the ship's course does not change, the total compass error thus found may be used without separating it into its component parts. It should be increased or decreased, however, as the ship proceeds, by the amount of any *change* of the variation that the chart may show.

385. If there is any fear of the weather being cloudy at noon, the navigator should take the precaution, when the sun has changed about 30° in azimuth, to observe a second altitude and to record the appropriate data for another sight, though this need not actually be worked unless the meridian observation is lost. If it is required it may be worked for either a time sight or ϕ' ϕ'' sight, or by the Saint Hilaire method, according to circumstances, and a second Sumner line thus obtained, whose intersection with earlier Sumner line, brought forward for the run in the interval between the sights, will give the ship's position.

386. NOON SIGHTS.—Between 11 and 11.30 o'clock (allowing for gain or loss of time due to the day's run) the ship's clocks should be set for the L. A. T. of the prospective noon position. The noon longitude may be closely estimated from the morning sight and the probable run. The navigator should also set his own watch for that time, to the nearest minute, and note exactly the number of seconds that it is in error. He may now compute the constant (art. 325, Chap. XII) for the meridian altitude. The daily winding of the chronometer is a most important feature of the day's routine, and may well be performed at this hour. At a convenient time before noon, the observations for meridian altitude are commenced and continued until the watch shows L. A. noon, at which time the meridian altitude is measured and the latitude deduced.

If the weather is cloudy and there is doubt of the sun being visible on the meridian an altitude may be taken at any time within a few minutes of noon, the time noted, and the interval from L. A. noon found from the known error of the watch. It is then the work of less than a minute to take out the a from Table 26, the at^2 from Table 27, and apply the reduction to the observed altitude to obtain the meridian altitude. Indeed, the method is so simple that it may be practiced every day and several values of the meridian altitude thus obtained, instead of only one.

387. It now becomes necessary to find the longitude at noon. This may be done graphically by a chart or by computation. The former plan needs no explanation. There are a number of variations in the methods of computation, one of which will be given as a type.

By the ship's run, work back the noon latitude to the latitude at a. m. time sight. If the Sumner line was found from two assumed latitudes which differed $+m$ minutes, while the corresponding longitudes differed $\pm n$ minutes, then 1′ difference of latitude causes $\pm\frac{n}{m}$ minutes difference of longitude. If the true latitude at sight is $\pm x$ minutes from one of the assumed latitudes, then $\pm x\times\frac{n}{m}$ is the corresponding difference of longitude. If the Sumner line was found from one assumed latitude and an azimuth, Z, the longitude factor of the line may be found from Table 47; and this multiplied by the difference between the true and assumed latitude will give the correction to be applied to the computed longitude corresponding to the assumed latitude. Having thus the longitude at sight, the longitude at noon is worked forward for the run. If the sights show a considerable current it should be allowed for, both in working back the latitude and in bringing up the longitude for the run between the sight and noon.

Example: Suppose that an a. m. time sight, taken when the sun's azimuth was S. 39° 48′ E., has given a longitude of 30° 31′ W. when solved with a dead-reckoning latitude of 50° 54′ N. Suppose that when the noon latitude is worked back to the time of the a. m. sight, by means of the vessel's run, the true latitude at that time was found to be 50° 58′ N. The longitude was thus computed with a latitude that was 4′ too much to the southward. Find the corresponding error in longitude, and the longitude at the time of sight.

From Table 47, the longitude factor of the Sumner line passing through the geographical position whose latitude is 50° 54′ N. and whose longitude is 30° 31′ W., at right angles to the bearing S. 39° 48′ E., is 1.91. The computed longitude is therefore wrong by 4×1.91=7′.6; and according to the rule laid down in connection with the Explanation of Table 47, the correction in longitude must, in this case, be applied to the eastward.

Hence we have—

Longitude computed with D. R. Lat., 50° 54′ N	30° 31′ W.
Correction in long. due to change of 4′ in latitude to the northward	7. 6 E.
True longitude at the time of sight	30° 23. 4 W.

388. Current and Run.—The current may be found by comparing the noon positions as obtained by observation and by dead reckoning; and the day's run is calculated from the difference between the day's noon position by observation and that of the preceding day. To "current" is usually attributed all discrepancies between the dead reckoning and observations; but it is evident that this is not entirely due to motion of the waters, as it includes errors due to faulty steering, improper allowance for the compass error, and inaccurate estimate of the vessel's speed through the water.

The noon position by observation becomes the departure for the dead reckoning that follows.

389. Afternoon Sights.—The p. m. time sight and azimuth is similar to the morning observation.

390. Sumner Lines.—By performing the work that has just been described a good position is obtained at noon each day, which, in a slow-moving vessel with plenty of sea room, may be considered sufficient; but conditions are such at times as to render it almost imperatively necessary that a more frequent determination of the latitude and longitude be made. If the vessel is near the land or in the vicinity of off-lying dangers, if she is running a great circle course requiring frequent changes, if she is making deep-sea soundings, if she has just come through a period of foggy or cloudy weather, or if the indications are that she is about to enter upon such a period, or if she is running at high speed, it is obviously inexpedient to await the coming of the next noon for a fix. The responsibilities resting upon the navigator require that he shall earlier find his ship's position; and, generally speaking, the greater the speed made by the vessel the more absolute is this requirement.

The key to all such determinations will lie in the Sumner line, and a clear understanding of the properties of such a line will greatly facilitate the solutions. The mariner must keep in mind two facts: First, that a single observation of a heavenly body can never, by itself, give the *point* occupied by an observer on the earth's surface; and second, that whenever any celestial body is visible, together with enough of the horizon to permit the measuring of its altitude, an observer may thereby determine a *line* which passes through his own position on the earth's surface in a direction at right angles to the bearing of the body.

It may readily be seen that if two Sumner lines are determined the observer's position must be at their intersection, and that that intersection will be most clearly marked when the angle between the lines equals 90°; hence, if two heavenly bodies are in sight at the same time the position may be found from the intersection of their Sumner lines, the angle of intersection being equal to the horizontal angle between the bodies. If only one body is in sight, as is generally the case when the sun is shining, one line of position may be gotten from an altitude taken at one time, and a second line from another altitude taken when it has changed some 30° in azimuth—usually, a couple of hours later. Bringing forward the first line for the intervening run, the intersection may be found.

With the general principles of the Sumner line clearly before him, the navigator will find no difficulty in making the choice of available bodies. If about to take a star sight, and sky and horizon are equally good in all quarters, two bodies should be taken whose azimuths differ as nearly as possible by 90°. If one body can be taken on or near the meridian, its bearing being practically north or south, the resulting Sumner line will be east and west—that is, it may be said that whatever the longitude (within its known limits) the latitude will be the same; the other sight may then be worked as a time sight with this single latitude, and time will thus be saved. The same is true if Polaris is observed, and it is a very convenient practice to take an altitude of that star at dawn and obtain a latitude for working the a. m. time sight of the sun. A similar case arises when a body is observed on the prime vertical, its Sumner line then runs north and south and coincides with a meridian; if the other body is favorably located for a φ' φ'' sight, it may be worked with a single longitude and the latitude thus found directly.

If it is not possible to obtain two lines and thus exactly locate the ship, the indications of a single line may be of great value to the navigator. A Sumner line and a terrestrial bearing will give the ship's position by their intersection in the same manner as two lines of position or two bearings; or the position of the ship on a line may be shown with more or less accuracy by a sounding or a series of soundings. If the body be observed when it bears in a direction at right angles to the trend of a neighboring shore line, the resulting line will be parallel with the coast and thus show the mariner his distance from the land, which may be of great importance even if his exact position on the line remains in doubt. If the bearing be parallel to the coast line, then the Sumner line will point toward shore; the value of a line that leads to the point that the vessel is trying to pick up is amply demonstrated by the experience of Captain Sumner that led to the discovery of the method. (Art. 362, Chap. XV.)

For especially accurate work three Sumner lines may be taken, varying in azimuth about 120°; if they do not intersect in a point, the most probable position of the ship is at the center of the triangle that they form.

If two pairs of lines be determined, each pair based upon observation of two bodies bearing in nearly opposite directions and at about the same altitude, the mean position that results from the intersection of the four lines will be as nearly as possible free from those errors of the instrument, of refraction, and of the observer, which can not otherwise be eliminated. This is fully explained in article 449, Chapter XVII.

391. USE OF STARS, PLANETS, AND MOON.—It may be judged that the employment in navigation of other heavenly bodies than the sun is considered of the utmost importance, and mariners are urged to familiarize themselves with the methods by which observations of stars, planets, and the moon may be utilized to reveal to them the position of their vessels at frequent intervals throughout the twenty-four hours.

It should be remembered, however, that in order to be of value these observations must be accurate; and to measure an accurate altitude of the body above the horizon it is required not only that the body be visible but also that the horizon be distinctly in view. Care should therefore be taken to make the observations, if possible, at the time when the horizon is plainest—that is, during morning and evening twilight. It may be urgently required to get a position during hours of darkness, and a dim horizon line may sometimes be seen and an observation taken, using the star telescope of the sextant; if the moon is shining, its light will be a material aid; but results obtained from such sights should be regarded as questionable and used with caution. Altitudes measured, however, just before sunrise and just after sunset are open to no such criticism; a fairly well-practiced observer who takes a series of sights at such a time, setting the sextant for equal intervals of altitude, will find the regularity of the corresponding time intervals such as to assure him of accuracy.

392. IDENTIFICATION OF UNKNOWN BODIES.—On account of the very great value to be derived from the use of stars and planets in navigation, it is strongly recommended that all navigators familiarize themselves with the names and positions of those fixed stars whose magnitude renders possible their employment for observations, and also with the general characteristics—magnitude and color—of the three planets (Venus, Jupiter, and Mars) which are most frequently used. A study of the different portions of the heavens, with the aid of any of the numerous charts and books which bear upon the subject, will enable the navigator to recognize the more important constellations and single stars by their situation with relation to each other and to the pole and the equator.

It may occur, however, that occasion will arise for observing a body whose name is not known, either because it has not been learned, or because the surrounding stars by which it is usually identified are obscured by clouds or rendered invisible by moonlight or daylight. In such a case the observer may estimate the hour angle and declination (the hour angle applied to local sidereal time giving the right ascension), and the star or planet may thus be recognized from a chart or from an inspection of the Nautical Almanac. This rough method will generally suffice when the body is the only one of its magnitude within an extensive region of the heavens; but cases often arise where a much closer approximation is necessary, and more exact data are required for identification.

393. If in doubt as to the name of the body at the time of taking the sight, it should be made an invariable rule to observe its bearing by compass, whence the true azimuth may be approximately deduced by applying the compass error.

Star Identification Tables giving simultaneous values of the declination and hour angle, corresponding to the values of the latitude, altitude, and azimuth ranging from 0° to 88° in latitude and altitude and from 0° to 180° in azimuth, are published by the Hydrographic Office for the convenience of navigators. In the absence of these Star Identification Tables, the following method affords a means of identification:

$$\sin d = \sin \mathrm{L} \sin h + \cos \mathrm{L} \cos h \cos \mathrm{Z} \quad (1)$$
$$\sin t = \sin \mathrm{Z} \cos h \sec d \quad (2)$$

Having computed the value of d, the declination, from (1), noting carefully the sign of cosine Z, the value of t, the hour angle, is computed from (2). In the catalogues and lists giving the names and magnitudes of the stars, they are tabulated by their declinations and right ascensions because these coordinates are independent of diurnal rotation, and, this being so, it becomes necessary, on finding the hour angle from (2), to convert it into right ascension; and then, with the values of the declination and right ascension thus found, to scan the list of stars and find the name of that one whose catalogued coordinates best agree with these values. The stars that are bright enough to be observed with nautical instruments are so far apart in the firmament that the identification will be complete if the computation be but roughly made. The possibility that the observed body may be a planet must always be kept in mind in scanning the star table or chart.

Example: At sea, February 26, 1916, L. M. T. 6h 20m p. m. Weather overcast and cloudy. Observed the altitude of an unknown star through a break in the clouds to be 31° 30′ (true), bearing 285° (true). What is the name of the star? Ship's position, by D. R., latitude 35° 20′ N., longitude 60° W.

L	35° 20′	log sin	9.762	log cos	9.912		
h	31° 30′	log sin	9.718	log cos	9.931	log cos	9.931
Z	285° 00′	....		log cos	9.413	log sin	9.985
A	0.302	log...	9.480				
B	0.180	....		log...	9.256		
A+B = 0.302 + 0.180 = 0·482 = nat sin d ∴ d = 28° 49′...						log sec	10.057
t=H. A.=70°=4h 40m..................						log sin	9.973

Then converting the hour angle into right ascension, as follows:

	h	m
L. M. T.	6	20
R. A. M. S.	22	20
corr. for G. M. T.		+ 2
L. S. T.	4	42
H. A.	4	40
R. A.	0	02

The right ascension and declination of the unknown star, as we have now approximately found them, are $0^h\ 02^m$ and 28° 49′ N., respectively. The star is, therefore, α Andromedæ, whose tabulated coordinates are right ascension $0^h\ 04^m\ 02^s$ and declination 28° 37′ 36″ N.

394. Value of the Moon in Observations.—Next to the sun, the most conspicuous body in the heavens is the moon, and it may therefore frequently be employed by the mariner with advantage. Owing to its nearness to the earth and the rapidity with which it changes right ascension and declination, the various corrections entailed render observations of this body somewhat longer to work out, with consequent increased chances of error; and errors in certain parts of the work will have more serious results than with other bodies; the navigator will therefore usually pass the moon by if a choice of celestial bodies is offered for a determination of position; but so many occasions present themselves when there is no available substitute for the moon that the extra time and care necessary to devote to it are well repaid. During hours of daylight it is often clearly visible, and its line of position may cut with that of the sun at a favorable angle, giving a good fix from two observations taken at the same time, when the only other method of finding the position would be to take two sights of the sun separated by a time interval in which an imperfect allowance for the true run intervening would affect the accuracy of the result, or a clouding-over of the heavens would prevent any definite result whatever being reached; and during the night, the gleam upon the water directly below the moon may define the horizon and give opportunity for an altitude of that body when it is impossible to take an observation of any other. It has been the purpose of this work to point out the features of the various sights wherein the practice with the moon differs from that of the sun, stars, or planets; care and intelligent consideration will render these quite clear.

Besides its availability for determining Sumner lines of position, which it shares with other bodies, the moon affords a means for ascertaining the Greenwich mean time independently of the chronometer, thus rendering it possible to deduce the longitude and chronometer error. This is accomplished by the method of lunar distances.[1] If the Greenwich time given by an observation of lunar distance could be relied upon for accuracy, the method would be a great boon to the navigator; but this is not the case. The most practiced observer can not be sure of obtaining results as close as modern navigation demands, and the errors to which the method is subject are larger than the errors that may be expected in the chronometer, even when the instrument is only a moderately good one and its rate is carried forward from a long voyage. The method is not, therefore, recommended for use except where the chronometer is disabled or where it is known to have acquired some extraordinary error; and when lunar distances are resorted to care must be taken to navigate with due allowance for possible inaccuracy of the results. In this connection it is appropriate to say that the best safeguard against the dire consequences that may result from a disabled or unreliable chronometer is for every vessel to carry two—or, far better, three—of those instruments, the advantages of which plan are stated in article 265, Chapter VIII.

395. Employment of Bodies dependent upon their Position.—The practical navigator will soon observe that there are certain conditions in which bodies are especially well adapted for the finding of latitude, and others where the longitude is obtained most readily.

Taking the sun for an example, when a vessel is on the equator and the declination is zero, that body will rise due east of the observer and continue on the same bearing until noon, when for an instant it will be directly overhead, with a true altitude of 90°, and will then change to a bearing of west, which it will maintain until its setting. In such a case any observation taken throughout the day will give a true north-and-south Sumner line, defining longitude perfectly, but giving no determination of the latitude, excepting for a moment only when the body is on the meridian. With the exception noted, all efforts to determine the latitude will fail. The reduction to the meridian takes the form $\frac{0}{0}$, becoming indeterminate, and in the ϕ' ϕ'' sight the cosine of ϕ' will assume a value that corresponds alike to any angle within certain wide limits—the limits within which the circle of equal altitude has practically a north-and-south direction. In conditions approximating to this we may obtain a longitude position more easily than one for latitude, even within a few minutes of noon.

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[1] The tables of lunar distances have been omitted from the American Ephemeris and Nautical Almanac after the volume for the year 1911.

As the latitude and declination separate, conditions become more favorable for finding latitude and less so for longitude; the intermediate cases cover a wide range, wherein longitude may be well determined by observations three to five hours from the meridian, and latitude by those within two hours of meridian passage. As extreme conditions are approached the accuracy of longitude determinations continues to decrease; at a point in 60° north latitude, when the sun is near the southern solstice, its bearing differs only 39° from the meridian at rising; or, in other words, even if observed at the most favorable position, the resulting Sumner line is such that 1′ in latitude makes a difference of 1.3 miles of departure, or 2′.6 of longitude, and is far better for a latitude determination than for longitude. And in higher latitudes still this condition is even more marked.

Having grasped these general facts, the navigator must adapt his time for taking sights to the circumstances that prevail, and when the sun does not serve for an accurate determination of either latitude or longitude the ability to utilize the stars, planets, and moon as a substitute will be of the greatest advantage.

396. Use of Various Sights.—Except when employing the method of Saint Hilaire (Chapter XV), the navigator may sometimes be in doubt as to the best method of working a sight. No rigorous rules can be laid down, and experience alone must be his guide. In a general way it may be well, when the body is nearer to the prime vertical than to the meridian, to work it for longitude, assuming latitude, and using the time sight; and when nearer the meridian to work it for latitude, assuming longitude, by the ϕ' ϕ'' method. The time sight is more generally used than the other, it has wider limits of accurate application and is probably a little quicker; but as the meridian is approached and the hour angle decreases small errors in the terms make large ones in the results. The ϕ' ϕ'' or latitude method should not ordinarily be employed beyond three hours from the meridian, and then only when the body is within 45° of azimuth from the meridian and has a declination of at least 3°; with an hour angle of 6^h (90°) or a declination of 0° the trigonometric functions assume such form that the method is not available; nor does it give definite results when the azimuth is 90° or thereabouts.

When the body is close enough to the meridian for the method of reduction to the meridian to be applicable, that method is to be preferred because of its quickness and facility. It should be noted, however, that, though close enough to employ the reduction, it may not be sufficiently correct to assume that the body bears due north or south, and the sight should be worked with two longitudes, or the Sumner line determined by the azimuth, unless the bearing nearly coincides with the direction of the meridian.

397. Working to Seconds and Accuracy of Determinations.—The beginner who seeks counsel from the more experienced in matters pertaining to navigation will find that he receives conflicting advice as to whether it is more expedient to carry out the terms to seconds of arc, or to disregard seconds and work with the nearest whole minute.

It is a well-recognized fact that exact results are not attainable in navigation at sea; the chronometer error, sextant error, error of refraction, and error of observation are all uncertain; it is impossible to make absolutely correct allowance for them, and the uncertainty increases if the position is obtained by two observations taken at different times, in which case an exactly correct allowance for the intervening run of the ship is an essential to the correctness of the determination. No navigator should ever assume that his position is not liable to be in error to some extent, the precise amount depending upon various factors, such as the age of the chronometer rate, the quality of the various instruments, the reliability of the observer, and the conditions at the time the sight was taken; perhaps a fair allowance for this possible error, under favorable circumstances, will be 2 miles; therefore, instead of plotting a position upon the chart, and proceeding with absolute confidence in the belief that the ship's position is on the exact point, one may describe, around the point as a center, a circle whose radius is 2 miles—if we accept that as the value of the possible error—and shape the future courses with the knowledge that the ship's position may be anywhere within the circle.

It is on account of this recognized inexactness of the determination of position that some navigators assume that the odd seconds may be neglected in dealing with the different terms of a sight; the average possible error due to this course is probably about one minute, though under certain conditions it may be considerably more. It is possible that, in a particular case, the error thus introduced through one term would be offset by that from others, and the result would be the same as if the seconds had been taken into account; but that does not affect the general fact that the neglect of seconds as a regular thing renders any determination liable to be in error about one minute. Those that omit the seconds argue, however, that since, in the nature of things, any sight may be in error two minutes, it is immaterial if we introduce an additional possibility of error of one minute, because the new error is as liable to decrease the old one as to increase it; but the fallacy of the argument will be apparent when we return to the circle drawn around our plotted point. The eccentricity of the sextant may exactly offset the improper allowance for refraction, and the mistake in the chronometer error may offset the observer's personal error, but unless we know that such is the case—which we never can—we have no justification for doing otherwise than assume that the ship may be any place within the 2-mile circle. If, now, we increase the possible error by 1 mile, our radius of uncertainty must be increased to 3 miles, and the diameter of the circle, representing the range of uncertainty in any given direction, is thereby increased from 4 to 6 miles.

It is deemed to be the duty of the navigator to put forth every effort to obtain the *most probable* position of the ship, which requires that he shall eliminate possible errors as completely as it lies within his power to do. By neglecting seconds he introduces a source of error that might with small trouble be avoided. This becomes of still more importance since modern instruments and modern methods constantly tend to decrease the probability of error in the observation, and to place it within the power of the navigator to determine his ship's position with greater accuracy.

398. There is a more exact way of defining the area of the ship's possible position than that of describing a circle around the most probable point, as mentioned in the preceding article, and that is to draw a line on each side of each of the Sumner lines by which the position is defined, and at a uniform distance therefrom equal to the possible error that the navigator believes it most reasonable to assume under existing conditions; the parallelogram formed by these four auxiliary lines marks the limit to be assigned for the ship's position; this method takes account of the errors due to poor intersections, and warns the navigator of the direction in which his position is least clearly fixed and in which he must therefore make extra allowance for the uncertainty of his determination.

It must be remembered in this connection that no position can ever be obtained, when out of sight of the land, except from the intersection of two Sumner lines, whether or not the lines are actually plotted; thus, a meridian altitude gives a Sumner line that extends due east and west, and a sight on the prime vertical a line that extends north and south, though it may not have been considered necessary to work the former with two longitudes or the latter with two latitudes.

399. THE WORK BOOK AND FORMS FOR SIGHTS.—The navigation work book, or sight book, being the official record of all that pertains to the navigation of the ship when not running by bearings of the land, should be neatly and legibly kept, so that it will be intelligible not only to the person who performed the work, but also to any other who may have reason to refer to it.

Each day's work should be begun on a new page, the date set forth clearly at the top, and preferably, also, a brief statement of the voyage upon which the ship is engaged. It is a good plan to have the dead reckoning begin the space allotted for the day, and then have the sights follow in the order in which taken. The page should be large enough to permit the whole of any one sight to be contained thereon without the necessity of carrying it forward to a second page. No work should be commenced at the bottom of a page if there is not room to complete it. Every operation pertaining to the working of the sights should appear in the book, and all irrelevant matter should be excluded.

It is well to observe a systematic form of work for each sight, always writing the different terms in the same position on the page; this practice will conduce to rapidity and lessen the chances of error. In order to facilitate the adoption of such a method, there are appended to this work (Appendix II) a series of forms that are recommended for dead reckoning, and for the various sights of the sun, stars, planets, and moon, respectively. For beginners, these are deemed of especial importance, and it is recommended that, until perfect familiarity with the different sights is acquired, the first step in working out an observation be to write down a copy of the appropriate blank form, indicating the proper sign of application of each quantity (for which the notes will be a guide), and not to put in any figures until the scheme has been completely outlined; then the remainder of the work will consist in writing down the various quantities in their proper places and performing the operations indicated.

The navigator may make up his work book by having printed forms of the various sights which can be placed in a loose-leaf binder when they have been filled in with his computations. Instead of printed forms on separate sheets, he may employ rubber stamps of the various forms of sights which he may stamp in his work book or on loose leaves.

THE SPECIFIC STEPS FOR CARRYING OUT THE DAY'S WORK.

400. The day's work as described herein is so laid out that the true position at noon is known some few minutes before noon, as, when cruising in company, naval vessels have to make their noon position report by signal at exactly 12 o'clock. When cruising singly the noon position need not be known until after 12 o'clock, but it is advisable to do a day's work always in one way, and, therefore, the plan of getting the correct noon position before noon will be followed.

401. THE TIME TO TAKE AN A. M. OBSERVATION.—The navigator of a vessel cruising may, by dead reckoning or by plotting on a chart, predict the approximate position of the ship the following morning, and from that position may easily determine the best time to observe the sun (or other body) for longitude. Having determined his approximate 8 a. m. position, he takes from the Nautical Almanac the declination of the sun for Greenwich noon of that day. With the latitude of the 8 a. m. position and declination for the day, he enters the Azimuth Tables and takes out the local apparent time when the sun will bear 90°. By getting the error of his watch on local apparent time for the approximate 8 a. m. longitude, he may easily find the watch time when the sun will bear 90°, which is the time he should take his sight. Suppose on the evening of July 18, 1916, a navigator finds that at 8 a. m. *the next day* he will be in approximate Lat. 35° 12′ N., Long. 65° 15′ W., and wishes to find at what time *by his watch* the sun will be on the prime vertical. He compares his watch with the chronometer, of which he knows the correction, and which is, we will say, slow 1^m 10^s on G. M. T., and finds that when the chronometer reads, say 11^h 59^m 30^s, the watch reads 7^h 15^m 12^s. He then does the following work:

He takes from the Nautical Almanac the declination and the equation of time for Greenwich mean noon on July 19 and finds Dec. = 20° 52′ N.; Eq. t. 6^m 04^s, subtractive from mean time.

With Lat. 35°.2 N., Dec. 21°.0 N., enter the Azimuth Tables, and find, for a bearing of 90°, the L. A. T. is about 8^h 10^m.

Write down the reading of the chronometer face at comparison		11^h	59^m	30^s
Apply the chronometer correction	+		1	10
G. M. T. of the time of comparison		12	00	40
Apply equation of time	−		6	04
Greenwich apparent time of comparison		11	54	36
For Long. 65° 15′ W., λ=4^h 21^m 00^s. Apply λ		4	21	00
At time of comparison the L. A. T. at the 8 a. m. position was		7	33	36
At time of comparison the watch time was		7	15	12
Error of watch on L. A. T. of 8 a. m. position			18	24 slow.
L. A. T. when sun is on prime vertical		8	10	
Watch time to take a. m. observation		7	51	36

The observation should therefore be taken when the watch face reads about 7–52, which will bring the sun very close to the prime vertical.

When the latitude and declination are of different names the sun crosses the prime vertical before rising. In that case, the observation is taken as soon as the sun is sufficiently high to be unaffected by any peculiar condition of the atmosphere, usually about an hour after sunrise. The L. A. T. of sunrise and sunset is given at the bottom of the page in the Azimuth Tables. Suppose in the above example the approximate 8 a. m. latitude was 35°.2 S. instead of 35°.2 N. Entering the tables with Lat. and Dec. of different names, we find the time of sunrise is about 7 a. m. The observation should therefore be taken at about 8 a. m. L. A. T., the watch time of which can be found in the same way as explained above.

In a similar manner Azimuth Tables may be used to find the best time to take p. m. observations for longitude.

402. The Morning Work of the Navigator.—The navigator, having determined the time at which he will take his morning observation, is called sufficiently early to be ready for work about 15 minutes before the time chosen.

The first thing the navigator does is to check up his time. To save the trouble of going below to compare the watch with the standard chronometer each time that an observation is taken, most navigators keep the hack chronometer in the chart house and use it for comparisons during the day. It is necessary to check the hack with the standard chronometer each day to make sure of its error on G. M. T. and rate. This comparison is made the first thing in the morning, the date, the error on G. M. T., and the rate of the hack being written on a slip of paper that is placed in the hack case. The hack is then taken to the chart house and is used for the day's work. As hack chronometers frequently have high daily rates, an additional correction sometimes has to be made for the rate when observations have been taken some hours after the comparison. The hack is sometimes used for marking the time of observation, and. when so used. the G. M. T. is at once obtained by applying the hack error.

Having checked up the hack chronometer, the navigator then prepares his sextant and takes it, with his watch and notebook, to the place from which he takes his observations. At about the time he has selected for his purpose, he observes altitudes of the sun, which, with the corresponding watch times are noted in his notebook. The patent log is read while the observations are being taken and the reading is entered in the notebook. The navigator then goes to the standard compass and gets a bearing of the sun, which with the watch time of the bearing and the compass heading of the ship is entered in the notebook. Either just before or just after observing the altitude of the sun with the sextant, the index correction should be found and entered in the notebook. The navigator next compares his watch with the hack chronometer and gets the C-W, which is also entered in the notebook. From the log book he gets the courses and distances run from the last "fix" and enters them in his notebook. This completes the data for his morning's work.

The computations are then made in the navigator's work book. The first step is to work up the dead reckoning from the last "fix" to the time of sight. It may be well here to call the attention of the student to the fact that for "distance run" the propellers frequently are a more accurate gauge than the patent log which sometimes gets foul. In a smooth sea the distance by revolutions is usually very accurate, especially if the effect of the condition of the bottom as to fouling is known. In heavy weather the patent log is a better gauge as the effects of the wind and sea on the speed of the ship are hard to determine. But for distance run both the patent log and revolutions should be considered, and, if there is a discrepancy between them, it should be investigated and the more accurate distance should be used.

Having brought the dead reckoning up to the time of sight, the latitude so found is taken as the base of the computation of the longitude by observation. It is assumed that the student is familiar with the various methods of getting a line of position from an observation. Any one of the various methods gives the same line and the choice of method is naturally the choice of the individual.

Having obtained the line of position, the longitude factor is next found, as explained in article 387. The longitude factor is used twice, first to find the longitude by observation corresponding to the D. R. latitude, and again after the noon latitude is determined, to find the true noon longitude. As soon as the longitude factor has been obtained, the longitude by observation corresponding to the D. R. latitude is found, and it is this point on the line of position that is used for the rest of the work to noon. This point, corrected for run, is also the point adopted as the 8 a. m. position, and as by using it future steps are simplified, it is advisable always to work from this point. Of course, any other point on the line can be moved up, and the final result will be the same, but the computation will be a little more complicated.

Having obtained the position at time of sight (D. R. Lat., Long. by obs.) and the longitude factor, the navigator next proceeds to get the compass error. The work he has already performed in getting the line of position gives him certain data that will shorten his work in finding the compass error. If the sight has been worked out as a Sumner line the navigator, by taking the L. A. T. found by his computation and correcting it for the difference between the watch times of his observation for altitude and observation for azimuth, may obtain at once the L. A. T. of the time at which he took the sun's azimuth. With this L. A. T., and the Lat. and Dec. used in working out his sight, he may at once find from the Azimuth Tables the true bearing of the sun and get the compass error. If the line of position has been obtained by one of the tangent methods, the navigator has, in his computation, determined the true bearing of the sun at the time of sight. All he has to do to get the true azimuth for compass error is to correct this bearing for the change in azimuth due to the difference in time between his observation for altitude and his observation for azimuth. This correction is easily found from the Azimuth Tables by inspection.

This completes the morning work when the amount of work each day is a minimum. When very accurate positions are required at other times than at noon, as for instance, when a vessel is scouting, when in dangerous waters, moving at high speed, or when making a landfall, other lines of position are worked out, and the ship's position found on each line by moving the next preceding line up to it for run. For instance, lines obtained from morning twilight sights of the moon, stars, or planets, may be run up to the 8 a. m. line, the 8 a. m. line may be run up to one taken at 9.30 or 10, or later, and so on. When getting the position by the intersection of lines moved up for run, it is usual to perform the work on the plotting charts supplied for this particular purpose. These charts are Mercator projections covering each 5° of latitude from 0° to 60°. The parallels are numbered for every degree of latitude, and the navigator selects the chart covering the latitude in which he is working. The meridians on these charts, not being numbered, the navigator is left free to mark them with the longitudes through which he is working. The charts are of large scale, and, being on heavy paper, may be used over and over, lines on these being drawn in lightly and erased when no longer required.

Intersections of lines of position may be computed, as explained in Chap. XV, when there are no charts at hand suitable for plotting the lines graphically. Special plotting sheets prepared by the United States Hydrographic Office are supplied to vessels of the Navy.

403. THE WORK BETWEEN 11 A. M. AND NOON.—Two important steps, not usually fully explained in the text books, must be studied. These are: *First*, to determine the exact run from the time of the a. m. sight to local apparent noon; *second*, to set the watches and clocks to the local apparent time of the place the ship will be at local apparent noon.

If the ship has been making westing, the watches and clocks will be ahead of the local apparent time of the noon position and will have to be set back by the amount of the change in longitude. As the change of time is made between 11 a. m. and noon, it will be seen that the elapsed time between the time of the a. m. sight and the new watch time of noon will be more than the watch face shows by the amount the watch has been set back, and this difference must be allowed for in computing the run to noon. In the same way, if the ship has been making easting, the clocks and watches will have to be set ahead and the elapsed time between the time of the a. m. sight and the new watch time of noon will be less than the watch face shows by the amount the watch has been set ahead, and must be allowed for in computing the run to noon. It must be remembered that this time can not be computed exactly, but it can be approximated very closely in this way. Suppose a ship has been steaming on course 66° true, and the navigator finds from his a. m. observation taken at watch time, $8^h\ 00^m\ 03^s.5$, that the L. A. T. for the position, Lat. by D. R. 38° 03′.2 N., Long. by obs. 72° 50′ 26″ W., is $8^h\ 17^m\ 23^s.9$. He sees at once that at 8 a. m. his watch is already slow $17^m\ 20^s.4$ on L. A. T. Now, if he continues on this course 66° true, at a speed of 11.7 knots per hour, the watch will be still slower at noon. He therefore turns to the Traverse Tables and finds that on that course and at a speed of 11.7 knots the ship will each hour go 10.69 miles to the eastward, which, in Lat. 38°, makes a change of longitude of 13′.6 each hour. Now, from time of sight to 11 a. m. the change of longitude will be $3 \times 13'.6 = 40'.8$ of longitude, which is equal to a further loss of $2^m\ 43^s.2$ of time; but the watch was already slow $17^m\ 20^s.4$, so that at 11 a. m. the watch will be slow $20^m\ 03^s.6$, and the time to noon will be $1^h - (20^m\ 04^s)$, the difference due to change in longitude in $39^m\ 56^s\ (1^h - 20^m\ 04^s)$. Now $39^m\ 56^s = 0.66^h$ and the change of longitude $= 0.66 \times 13'.6 = 9'.0$ of long. $= 36^s.0$ of time. Hence the total amount the time will be changed will be:

Change to time of a. m. sight	$17^m\ 20^s.4$
Change between a. m. sight and 11 a. m	2 43.2
Change between 11 a. m. and L. A. noon	0 36.0
Total change	20 39.6

and the run to noon will be four hrs. minus this change $= 3^h\ 39^m\ 20^s.4 = 3.66$ hrs. The distance run to noon will be $3.66^h \times 11^{kts}.7 = 42^{kts}.8$.

The navigator can now run the a. m. point, determined by dead reckoning latitude and longitude by observation, up to noon, and, after that he is ready to set his watch and clocks to the time of the coming local apparent noon position.

404. If the body observed for the a. m. sight was on or near the prime vertical, the longitude found from it would be correct for the time of observation, since an error in latitude makes no change in the longitude. This longitude when compared with the longitude by dead reckoning at the time of sight will show if there has been an easterly or westerly set of the current, and the amount of it. If a current is found and allowed for, for the time of the run from time of sight to noon, the noon longitude can be found very accurately. If the heavenly body used for the a. m. observation was not near the prime vertical, the exact easterly or westerly set can not be determined; but a close approximation to it can generally be made by comparing the longitude found by observation with the D. R. longitude, and the current so found should be allowed for in running the a. m. point up to noon. The error will be small and will give results sufficiently accurate for ordinary work. Having allowed for easterly or westerly current and having run the a. m. position point by observation up to noon, the navigator can then set his watch to local apparent time of the noon position, and his watch can be used to set the deck clocks. A convenient way to set the watch is as follows: Having looked at the hack face and found what it reads, say $4^h\ 09^m\ 50^s$, let it be determined to set the watch to the correct local apparent time of the noon position when the hack face reads $4^h\ 15^m\ 00^s$.

Write down reading of hack face at time watch is to be set	4^h	15^m	00^s
Apply the hack correction (in this case hack is $5^m\ 38^s$ fast on G. M. T.)	(−)	5	38
This gives G. M. T. at which watch is to be set to L. A. T	4	09	22
Apply equation of time corrected for longitude of noon position	(+) 11		33.8
This gives G. A. T. of time watch is to be set	4	20	55.8
Now apply longitude for noon position (in this case)	4	48	23
Watch face should read	11	32	32.8

The watch is now to be set so that, at $4^h\ 15^m\ 00^s$ by hack, the watch face will show as near $11^h\ 32^m\ 33^s$ as possible. It will be found, since the second hand of a watch can not be set, that the watch can not be set to the exact reading. By care, however, the watch can be set so that it will be 30 seconds or less fast or slow on the desired time. The number of seconds the watch is fast or slow on L. A. T. should be noted in the work book, as it will be a help in taking near-noon sights to get the correct L. A. T. at once from the reading of the watch face instead of comparing the watch again with the chronometer. The watch being set as nearly as possible to the correct L. A. T. and the error being recorded, the deck clocks are set; and the navigator then proceeds to work up his constants for his near-noon observations for latitude, and completes all his forms and fills them out as far as possible before taking the observations.

405. Now suppose the navigator wishes to take his observations at 15, 10, and 5 minutes before local apparent noon and desires to get constants for these times to which he can apply his sextant altitudes and at once get his correct noon latitude. To find the watch times at which he should take these observations, he must know the error of his watch on local apparent time of the place of observation. He knows the error of his watch on the L. A. T. of the noon position (in this case we will suppose the watch is 18^s fast). He knows that on course 66° true, speed 11.7 knots, in Lat. 38°, that in 1 hour he changes longitude 13′.6. Therefore 15 minutes before noon the ship will be 3′.4 of longitude west of where it will be at noon $= 13^s.6$ of time. Hence the observation 15 minutes before noon should be taken at watch time $11^h\ 45^m\ 00^s + 18^s$ (= amount watch is fast on L. A. T. of noon position) $+ 13^s.6$ (= amount watch is fast on L. A. T. of place of first near-noon observation) $= 11^h\ 45^m\ 31^s.6$. Similarly the observation taken 10^m before noon should be taken at watch time $11^h\ 50^m\ 00^s + 18^s + 9^s.1$ (= amount watch is fast on L. A. T. of place of second observation) $= 11^h\ 50^m\ 27^s.1$. The observation taken 5 minutes before noon should be taken at watch time $11^h\ 55^m\ 00^s + 18^s + 4^s.5$ (= amount watch is fast on L. A. T. of place of third observation) $= 11^h\ 55^m\ 22^s.5$. A meridian altitude would of course be taken at watch time $12^h\ 00^m\ 18^s$.

Having obtained the watch times of the observations, the navigator next works out the constants. These constants are obtained in the same way as meridian altitude constants but to each are applied two corrections to the meridian altitude constant. These are:

(1) at^2 or the correction to be applied to an observed altitude near noon to make it a meridian altitude.

(2) ΔL or the difference in latitude for the run from the time of observation to noon.

In working out the constant, the method of obtaining a meridian altitude constant is followed and the two corrections mentioned above are applied to it. In getting a meridian altitude constant, one has first to ascertain the approximate altitude. If the student will in every case plot his elements roughly on the plane of the meridian, putting O, the observer, at the center, a horizontal line through the O with the right end marked S for south, and the left end N for north, to represent the horizon, and draw a vertical line upward from O (marking its intersection with the circle Z) to represent the zenith, he can by inspection write out his formulæ and see exactly how to apply all corrections. A few minutes' study will make this method clear and will fully repay the very slight mental effort required to master it.

Now suppose L is the latitude of the noon position and L′ the latitude of the point from which the near-noon observation was taken. Then $L = L' \pm \Delta L$ where ΔL is the change in latitude from the time of observation to noon.

Suppose, by inspection of the figure we have drawn, we see that for a meridian altitude,

$$L' = 90^\circ - d - \text{obs. alt.} \pm \text{corr. to alt.}$$

Now when the observed altitude is taken before noon the correction at^2 has to be applied to it to bring it to what the meridian altitude would be. Therefore, for an altitude taken before noon,

$$\begin{aligned} L' &= 90^\circ - d - (\text{obs. alt.} + at^2) \pm \text{corr. to alt.} \\ &= 90^\circ - d - \text{obs. alt.} - at^2 \pm \text{corr.} \\ L &= 90^\circ - d - \text{obs. alt.} - at^2 \pm \text{corr.} \pm \Delta L. \\ &= K - \text{obs. alt.} \\ \text{or } K &= 90^\circ - d - at^2 \pm \text{corr.} \pm \Delta L. \end{aligned}$$

Having the watch time at which the near-noon observation is taken and K corresponding to it, it is only necessary to apply the observed altitude to its proper K to get the correct noon latitude. Having the *correct* noon latitude, find by how many minutes it differs from the D. R. noon latitude and multiply this difference by the longitude factor to get the correction to be applied to the 8.00 a. m. longitude by observation run up to noon, in order to get the correct noon longitude. This part of the work is done roughly on deck in the navigator's note book as soon as the altitude is taken. To facilitate this work the navigator writes his data in his note book in the following form, filling the blank spaces after getting his altitude:

For watch time	$11^h\ 45^m\ 30^s$	$11^h\ 50^m\ 26^s$	$11^h\ 55^m\ 22^s$	$12^h\ 00^m\ 18^s$
K	84 54 44	84 59 03	85 01 29	85 02 02
Obs. Alt.				
Noon Lat. by Obs.				
Mean				
Noon Lat. by D. R.	38° 20′ 35″			
D L				
Long. factor (Tab. 47)	.65			
Corr. in Long.				
Noon Long. by a. m. Obs.	72° 05′ 44″			
True longitude at noon				

406. Having obtained the correct noon position in the above manner, the navigator completes his work in his work book and plots the ship's position on the chart. Having the correct noon position, he compares it with his previous noon position (or point of departure) and gets the true course and distance made good. Having the position by dead reckoning and by observation, he gets the set and drift of the current. He then computes the total distance gone since leaving port and the distance yet to go to his destination. Blank forms for the noon report are arranged for the following data:

(1) Lat. by observation.
(2) Long. by observation.
(3) Lat. by D. R.
(4) Long. by D. R.
(5) Current: Set and Drift.
(6) Course made good.
(7) Distance made good since noon.
(8) Distance made good since departure.
(9) Distance to destination.

If the course sailed is a rhumb line, and the ship is practically on the line laid out as the track, no change of course is necessary. If the ship is decidedly off the rhumb line course as laid out, or is sailing on a great circle track that requires a change in compass course, the new course is laid out as soon as the true noon position is obtained. This completes the navigator's work to noon.

407. The Afternoon Work of the Navigator.—In the afternoon the navigator must take an observation for longitude. He selects a time when the sun is as near as possible to the prime vertical, which time is determined in the same way as explained for the a. m. observation. He runs his true noon position up to the time of his p. m. observation, making an allowance for any evident current that was found at noon. He then gets a position point on a line of position determined from his observation. This point is run up to 8 p. m. by dead reckoning, which position is plotted on the chart and completes the minimum navigation work for any day.

When particularly accurate positions are required, especially at 8 p. m., the navigator takes an additional observation of the sun, or of some other heavenly body at twilight, and gets the intersection of two lines of position. Or he may get a line for longitude and a line for latitude by an altitude of Polaris or another star. In this way the navigator may, at either morning or evening twilight, get a very accurate fix; and this is done frequently. In fact, fixes obtained from observations of two heavenly bodies taken at about the same time are the most accurate fixes that can be obtained at sea, as the intersection of the two lines of position give a position point that is correct at the time, no matter what the current is. Careful navigators will therefore take such observations and the student should prepare himself to do so. The methods of using position points obtained in this way are exactly the same as the methods of using the points already explained.

The following example will give a good idea of the minimum day's work for the navigator at sea. The form laid out is one that can always be followed. The cosine-haversine formula is used for getting the lines of position, but any other method may be substituted for it.

Example: On October 4, 1916, the U. S. S. *Delaware* left Hampton Roads for Lisbon. From the Chesapeake Capes the great circle course was followed. The distance to Lisbon by great circle course is 3,120 miles. It is 25 miles from Hampton Roads to the point from which the departure was taken. At 5 p. m., with Cape Henry Light bearing 301° (mag.), dist. 8.3 miles, took departure, set course 74° (p. s. c.) (Var. 5° W., Dev. 3° W.), and put over patent log, reading 0. (The point of departure is Lat. 36° 51′ 59″ N., Long. 75° 51′ 03″ W.)

The next morning by comparison with the standard, the hack chronometer was found to be $5^m\ 38^s$ fast on G. M. T. and gaining $1^s.5$ daily. At about 8 a. m., patent log, reading 175.0, the navigator took an a. m. observation for longitude: W. T. $8^h\ 00^m\ 03^s.5$; obs. alt. 22° 55′ 10″; I. C. +1′ 50″; ht. of eye 40 ft. The navigator then observed an azimuth of the sun as follows: W. T. $8^h\ 02^m\ 29^s$; bearing of sun p. s. c. 125° 30′; ship's head 74°. He then compared his watch with the hack as follows: hack face $1^h\ 13^m\ 00^s$; watch face $8^h\ 10^m\ 11^s$.

Perform the a. m. part of the day's work.

The ship continues on same course at same speed (11.7 knots). When the hack face reads $4^h\ 15^m\ 00^s$, at what time should the watch be set to be on local apparent time at the noon position?

If the watch was set 18 seconds fast on local apparent time at the noon position, work out constants for observations for latitude to be taken 15, 10, and 5 minutes before noon and at noon. Prepare all forms for the noon work.

The observed altitudes near noon were as follows: 15 minutes before, 46° 12′ 30″; 10 min. before, 46° 16′ 50″; 5 min. before, 46° 19′ 20″. The noon alt. was 46° 19′ 40″. The patent log read 217.5 at noon.

Complete the day's work for noon.

At noon the course was changed to 86° (p. s. c.), Var. 10° W., Dev. 4° W. Steamed until 4 p. m. on this course, when at W. T. $4^h\ 00^m\ 12^s$, obs. alt. of sun 18° 32′ 40″; C−W, $4^h\ 40^m\ 56^s$; I. C., +1′ 50″; ht. of eye, 40 ft.; patent log reading, 264.3.

Find position of ship at 4 p. m. by observation.

The course and speed remaining unchanged, find the 8 p. m. position.

October 5, 1916.—A. M. Work.

D. R. from point of departure to time of a. m. observation:

Course.	Var.	Dev.	Comp. error.	True course.	Dist.	N.	E.	D. Lo.
74° (p. s. c.)	5° W.	3° W.	8° W.	66°	175.0	71′.2	159.9	201′.4 E.

Point of departure:	Lat.	36° 51′ 59″ N.	Long.	75° 51′ 03″ W.
	D. L.	1 11 12 N.	D. Lo.	3 21 24 E.
D. R. position 8 a. m.:	Lat.	38 03 11 N.	Long.	72 29 39 W. $\lambda = 4^h\,49^m\,58^s.6$

A. M. Sights of ⊙

C. T.	$1^h\,13^m\,00^s$	Obs. alt. ⊙	22° 55′ 10″	(Tab. 46)	+7′ 42″	Dec.	4° 42′.7 S.	H. D.	−1′.0	Eq. t.	$11^m\,30^s.4$	H. D.	$+0^s.7$
W. T.	8 10 11	Corr. +	9 32	I. C.	+1 50	Corr. −	.95	G. M. T.	$.954^h$	Corr. +	0 .7	G. M. T.	$.954^h$
C−W.	5 02 49	h	23 04 42	Corr.	+9 32	d	4° 43′ 39″ S.	Corr.	−0′.954	Eq. t.	11 31.1	Corr.	$+0^s.667$
W. T.	8 00 03.5									(*Add* to *mean* time.)			
				t	$3^h\,41^m\,13^s$	log hav	9.33323						
C. T.	1 02 52.5			L	38° 03′ 11″ N.	log cos	9.89622						
C. C. −	5 38.0			d	4 43 39 S.	log cos	9.99852						
G. M. T.	0 57 14.5=0.954 hrs. on Oct. 5, 1916.			θ		log hav	9.22797	nat hav	.16903				
Eq. t. +	11 31.1			L∼d	42 46 50			nat hav	.13302				
G. A. T.	1 08 45.6			z	66 40 40			nat hav	.30205				
λ	4 49 58.6			Calculated h	23 19 20								
L. A. T.	8 18 47			Observed h	23 04 42								
t	3 41 13			Alt. diff.	14 38=14.6 on reverse bearing of sun.								

From Azimuth Tables: With Lat. 38° N., Dec. 5° S., & L. A. T. $8^h 20^m$, sun bears N. 117° 15′ E.

Corr. for Dec. 4°.7 S=.3×46 = −0° 14′
Corr. for L. A. T. $8^h 18^m.8$=.12×113 = −0 14
Corr. for Lat. 38°05′=.05×23 = +0 01

Total correction −0 27 − 0 27

NOTE.—[By using Weir's Azimuth Diagram the true bearing of the sun may be obtained without using the Azimuth Tables.]

True bearing of sun at time of sight 116 48
Reverse bearing of sun 296 48

With distance, 14′.6 (alt. diff.), on course=reverse bearing of sun.

True course	Dist.	N.	W.	D. Lo.
296°.8	14.6	6′.6	13.0	16′.5 W.

Lat. by D. R. 38° 03′ 11″ N. Long. 72° 29′ 39″ W.
D. L. 6 36 N. D. Lo. 16 30 W.

From Table 47, Long. factor .65
Diff. in Lat. 6′.6

Position point to be used if line is plotted Lat. 38 09 47 N. Long. 72 46 09 W.
Corr. to Long. to make it correspond to D. R. Lat. 4 17 W.

Corr. in Long. 4′.29 W.=4′ 17″ W.

At 8 a. m. for D. R. Lat. 38 03 11 N. Long. 72 50 26 W.

λ $4^h 51^m 21^s.7$

W. T. of a. m. sight $8^h 00^m 03^s.5$
W. T. of sun's compass bearing 8 02 29 .0

Diff. in time {2 25 .5; 2^m. 43}

Sun's true bearing at time of a. m. sight. 116° 48′
Change in azimuth for 2^m.43 from azimuth tables + 0 28

Sun's true bearing at time of compass bearing 117 16

Observed compass bearing of sun 125 30

Compass error 8 14 W.
Variation by chart 5 00 W.

Deviation of compass on ship's head 74° (p. s. c.) 3 14 W.

At a. m. observation the G. A. T. was $1^h 08^m 45^s$. 6
At a. m. observation the Long. by Obs. was 4 51 21 . 7

At a. m. observation the L. A. T. was 8 17 23 . 9
At a. m. observation the W. T. was 8 00 03 . 5

At a. m. observation the watch was 17 20 . 4 slow on L. A. T.

Long. at 8 a. m. by Obs. 72° 50′ 26″ W.
Long. at 8 a. m. by D. R. 72 29 39

Diff. in Long. due to current 20 47 =20′. 8 W.

Drift per hr. in Long. $\frac{20.8}{15^h}$ = 1′. 39

October 5, 1916.—Work from 11 a. m. to noon.

On course 66° (true), at speed 11.7 knots: Northing per hour=4.76. Easting per hour=10.69. D. Lo. per hour=13′.6.

Change in Long. per hour due to speed of ship 13′. 6 E.
Change in Long. per hour due to current 1 . 39 W.

Ship changes Long. per hour 12. 21 E.

∴ time to noon=$\{1^h-(19^m\ 46^s.9)\}=40^m\ 13^s.1=0^h.67$.
Change in Long. from 11 to 12=.67×12′.21=8′.2=$0^m\ 32^s.8$.

Change in Long. from 8 to 11 a. m.=12′.21×3^h=36′.63 — $2^m\ 26^s.5$
Watch slow on L. A. T. at 8 a. m. — 17 20. 4

At 11 a. m. watch is slow on L. A. T — 19 46. 9
— 0 32. 8

Total amount watch will be set ahead — 20 19. 7

∴ Time of run from 8 a. m. to noon will be $20^m\ 19^s.7$ less than $4^h=3^h\ 39^m\ 40^s.3=3^h.66$.

Change in Lat. from 8 a. m. to noon=$3^h.66$×4′.76=17′.4. N. Change in Long. $3^h.66$×12.21=44′.7. E.

At 8 a. m.: Lat. by D. R. 38° 03′ 11″ N.; Long. by D. R. 72° 29′ 39″ W.; Long. by Obs. 72° 50′ 26″ W.
Run to noon D. L. 17 24 N. D. Lo. 44 42 E. D. Lo. 44 42. E.

At noon: Lat. by D. R. 38 20 35 N. Long. by D. R. 71 44 57 W. 8 a. m. Long. run to noon } 72 05 44 W.
λ=$4^h\ 48^m\ 23^s$
(Used in Noon. Lat. Obs.)

G. A. T. $4^h\ 48^m\ 23^s$
Eq. t. − 11 34
G. M. T. 4 36 49

Set watch to L. A. T. when
C. T. $4^h\ 15^m\ 00^s$
C. C. − 5 38
G. M. T 4 09 22
Eq. t. + 11 33. 8
G. A. T. 4 20 55. 8
λ 4 48 23
L. A. T. 11 32 32. 8

Dec. 4^h 4° 46′. 5 S.
Corr. − 0 . 6
d 4 47 06 S.

H. D. −1′.0
G. M. T. $0^h.6$
Corr. −0′.6

Eq. t. 4^h $11^m\ 33^s.4$
Corr. + 0.4
Eq. t. 11 33 .8
(*Add* to *mean* time.)

H. D. + $0^s.7$
G. M. T. $0^h.6$
Corr. + $0^s.42$

In setting watch, left an error making watch 18^s fast on L. A. T.
L=90°−d−h, or approx. h=90°−(d+L).

d 4° 47′
L 38° 21′
d+L 43° 08′
Approx. h=46° 52′

d 4 47 06
Corr. + 10 52
d+Corr. 4 57 58

Corr. (Table 46) Approx. h=46° 52′ } + 9′ 02″
I. C. + 1 50
Total Corr. + 10′ 52″

L=L′±Δ L; L′=90°−d−obs. alt.−at^2±Corr. to alt. ∴ L=90°−d−at^2±Corr. to alt.±ΔL−obs. alt.=K−obs. alt.
or K=90°−d−at^2±Corr. to alt. ±ΔL. Since ship is making northing, Δ L in this case is +.

If watch is 18^s fast, the observations should be taken at watch times:	$11^h\ 45^m\ 18^s$	$11^h\ 50^m\ 18^s$	$11^h\ 55^m\ 18^s$	$12^h\ 00^m\ 18^s$
But change in λ from these watch times to noon=$\frac{12'.2}{4}$, $\frac{12'.2}{6}$, $\frac{12'.2}{12}$=3′.0, 2′.0, and 1′.0	0 12	0 08	0 04	0 00
Hence the watch times to take observations are	11 45 30	11 50 26	11 55 22	12 00 18

For Lat. 38°.3 N., and Dec. 4°.88 S., we find from Table 26 that a=2.27, and from Table 27,

$$\Delta L=\frac{4.76}{4},\ \frac{4.76}{6},\ \frac{4.76}{12}=1'.2,\ 0'.8,\ 0'.4$$

at^2	− 0° 8′ 30″	− 8′ 47″	− 0′ 57″	− 0′ 00″
ΔL	+ 0 1 12	+ 0 48	+ 0 24	+ 0 00
d+Corr.	− 4° 57′ 58″	− 4° 57′ 58″	− 4° 57′ 58″	− 4° 57′ 58″
	5° 05′ 16″	5° 00′ 57″	4° 58′ 31″	4° 57′ 58″
∴ K	84 54 44	84 59 03	85 01 29	85 02 02
Observed Alts.	46 12 30	46 16 50	46 19 20	46 19 40
Noon Lat. by Obs.	38 42 14 N.	38 42 13	38 42 09	38 42 22

Mean	38° 42′ 14″.5 N.
Noon Lat. by D. R.	38 20 35 .0 N.
D. L.	21 39.5= 21′.66
Long. factor (Tab. 47)	0.65
	10830
	12996
Corr. in Long.	14′ 05″=14′.0790
Noon Long. by a. m. Obs.	72° 05′ 44″ W.
True longitude at noon.	71° 51′ 39″ W.

Lat. left.	36° 51′ 59″ N.	Long. left	75° 51′ 03″ W.
Lat. in	38 42 14 N.	Long. in	71 51 39 W.
D. L.	1 50 15=110′.2	D. Lo	3 59 24=239′.4
Course made good 59¾° Dist.	219 miles.		Dep. 189.2.
Dist. made to point of Dep.	25		
Total distance made	244		
Total distance to destination	3,120		
Distance to go	2,876		

By Obs. Lat.	38 42.2 N.	Long.	71° 51.6 W.
By D. R. Lat.	38 20.6 N.	Long.	71 44.9 W.
D. L.	21.6 N.	D. Lo.	6.7 W.
			Dep.=5.3 W.

Current, 22.2 miles. Set=346°.
Drift=22.2 miles=1.2 knts. per hour.

From chart: Course for next 24 hrs.=72° (true).
Var. 10° W., Dev. 4° W. Compass course=86°

October 5, 1916.—P. M. Work.

Run to p. m. observation:

Course p. s. c.	Var.	Dev.	Comp. error.	True course.	Dist.	N.	E.	D. Lo.
86°	10° W.	4° W.	14° W.	72°	46.8	14′.5	44.5	57′.0 E.

Noon Lat. 38° 42.2 N. Long. 71° 51.6 W.
D. L. 14.5 N. D. Lo. 57.0 E.

4 p. m. D. R. Lat. 38 56.7 N. Long. 70 54.6 W. $\lambda = 4^h\ 43^m\ 38^s.4$

P. M. Sights of ☉

W. T. $4^h\ 00^m\ 12^s$
C.-W. 4 40 56

C. T. 8 41 08.0
C. C. − 5 38.5

G. M. T. 8 35 29.5 =8.59 hrs. Oct. 5th
Eq. t. + 11 36.8

G. A. T. 8 47 06.3
λ 4 43 38.4

L. A. T. 4 03 27.9

Obs. Alt. ☉ 18° 32′ 40″
Corr. + 8 57

h 18 41 37

(Table 46) +7′ 07″
I. C. +1 50

Corr. +8 57

t $4^h\ 03^m\ 28^s$
L 38° 56′ 42″ N.
d 4 50 59 S.

θ
L∼d 43 47 41

z 71 05 08
Calculated *h* 18 54 52
Observed *h* 18 41 37
Alt. Diff. 13 15=13′.2 on reverse bearing of sun.

Dec. 8^h 4° 50′.4 S.
Corr. − 0.59

d 4 50 59 S.

log hav 9.40922
log cos 9.89084
log cos 9.99844

log hav 9.29850

H. D. − 1′.0
G. M. T. $0^h.59$

Corr. −0′.59

nat hav .19884
nat hav .13908

nat hav .33792

Eq. t. 8^h, $11^m\ 36^s.4$
Corr. + .4

Eq. t. 11 36.8
(*Add* to *mean* time.)

H. D. $+0^s.70$
G. M. T. $0^h.59$

Corr. +0.413

From azimuth tables: With Lat. 38° N., Dec. 5° S. L. A. T. $4^h\ 00^m\ 00^s$ sun bears N. 113° 31′ W.
Corr. for Lat. 38°.94 =.94 × 19′ = +0° 18′
Corr. for Dec. 4.84 =.16 × 46 = −0 07
Corr. $4^h\ 03^m.5$ =.35 × 108 = −0 38

Total Corr. −0° 27′ − 0° 27′

True bearing N. 113° 04′ W.
Reverse bearing N. 66 56 E.

With distance, 13.2 (alt. diff.), on true course=N. 66° 56′ E.

True course.	Dist.	N.	E.	
66°.9	13.2	5′.2	12′.1	D. Lo.=15′.6 E.

Lat. by D. R. 38° 56′.7 N. Long. 70° 54′.6 W.
D. L. 5.2 N. D. Lo. 15.6 E.

4 p. m. Lat. 39 01.9 N. Long. 70 39.0 W.
D. L. 14.5 N. D. Lo. 57.4 E.

At 8 p. m. Lat. 39 16.4 N. Long. 69 41.6 W.

Run to 8 p. m.:

True course.	Dist.	N.	E.	
72°	46.8	14′.5	44.5	D. Lo.=57′.4 E.

Course for night=86° p. s. c.

CHAPTER XVII.

MARINE SURVEYING.

Omit.

408. DEFINITIONS.—Surveying is the art of making such field observations and measurements as are necessary to determine positions, areas, elevations, and movements on the surface of the earth, giving its characteristic features, such as, on land, the position of prominent objects, heights, and depressions, and on water, the depth, nature of bottom, position of shoals, and velocity of currents.

Topographic Surveying relates to the land, and *Hydrographic Surveying* to the water; and both are underlaid by *Trigonometrical Surveying* which, when it is carried on with high precision over such large areas as to contribute to form a basis for determining the size and shape of the earth, becomes a department of *Geodetic Surveying*.

It is not deemed appropriate to include in this work a complete treatise on marine surveying. The scope of this chapter will be to set forth such general information regarding the principles of surveying and the instruments therein employed as will give the navigator an intelligent understanding of the subject sufficient to enable him to comprehend the methods by which marine charts are made, and, if occasion should arise, to conduct a survey with such accuracy as the instruments ordinarily at hand on shipboard permit. For a more detailed discussion of marine surveying, the student is referred to the various publications which treat the subject exhaustively.

INSTRUMENTS EMPLOYED IN MARINE SURVEYING.

409. THE THEODOLITE AND TRANSIT.—The *Theodolite* (fig. 62) is an instrument for the accurate measurement of horizontal and vertical angles. While these instruments vary in detail as to methods of construction, the essential principles are always identical.

A telescope carrying crosshairs in the common focus of the object glass and eyepiece is so mounted as to have motion about two axes at right angles to one another; graduated circles and verniers are provided by which angular motion in azimuth and (usually) in altitude may be measured; and the instrument is capable of such adjustment by levels that the planes of motion about the respective axes will correspond exactly with the horizontal and the vertical.

The telescope is carried in appropriate supports upon a horizontal plate which has, immovably attached to it, one or more verniers, and which revolves just over a graduated circle that is marked upon the periphery of a second horizontal plate, a means of measuring the motion of the upper plate relative to the lower one being thus provided. Thumb screws are fitted by which the upper plate may be clamped to the lower, and (excepting in some simpler forms of the instrument) others by which the lower plate may be made immovable in azimuth, or allowed free motion, at will; all clamping arrangements include slow-motion tangent screws for finer control.

A vertical graduated circle, or arc, with a vernier, clamps, and tangent screws, is fitted to most theodolites, for the measurement of the angular motion of the telescope in altitude.

The theodolite usually carries a magnetic needle, with a graduated circle and vernier for compass bearings. The instrument is mounted upon a tripod, and levels and leveling screws afford a means of bringing the instrument to a truly horizontal position.

The *Transit* used in surveying is a modified form of the theodolite, and is generally employed where less accuracy is required; it takes its name from the fact that the telescope may be turned completely about its horizontal axis, or *transited,* without removal from its supports.

410. The *line of collimation* of a telescope is an imaginary line passing through the optical center of the object glass in a direction at right angles to that of its axis of rotation. This is also called the *axis of collimation.* The *line of sight* is an imaginary line passing through the optical center of the object glass and the point of intersection of the cross hairs.

A theodolite or transit, before it can be used for the accurate measurement of angles, must be in adjustment in the following respects: (*a*) The vertical axes of revolution of the upper and lower horizontal plates must be coincident; (*b*) the axis must be vertical and the plates horizontal when the bubbles of the levels are in their central positions; (*c*) the vertical cross hair must be perpendicular to the horizontal axis of the telescope; (*d*) the line of collimation must coincide with the line of sight; (*e*) the horizontal axis of the telescope must be perpendicular to the vertical axis of the instrument; (*f*) the bubble of the telescope level must stand at the middle of its scale, and the vertical circle must read zero, when the line of collimation is horizontal.

The last-named condition may be disregarded if vertical angles are not to be measured.

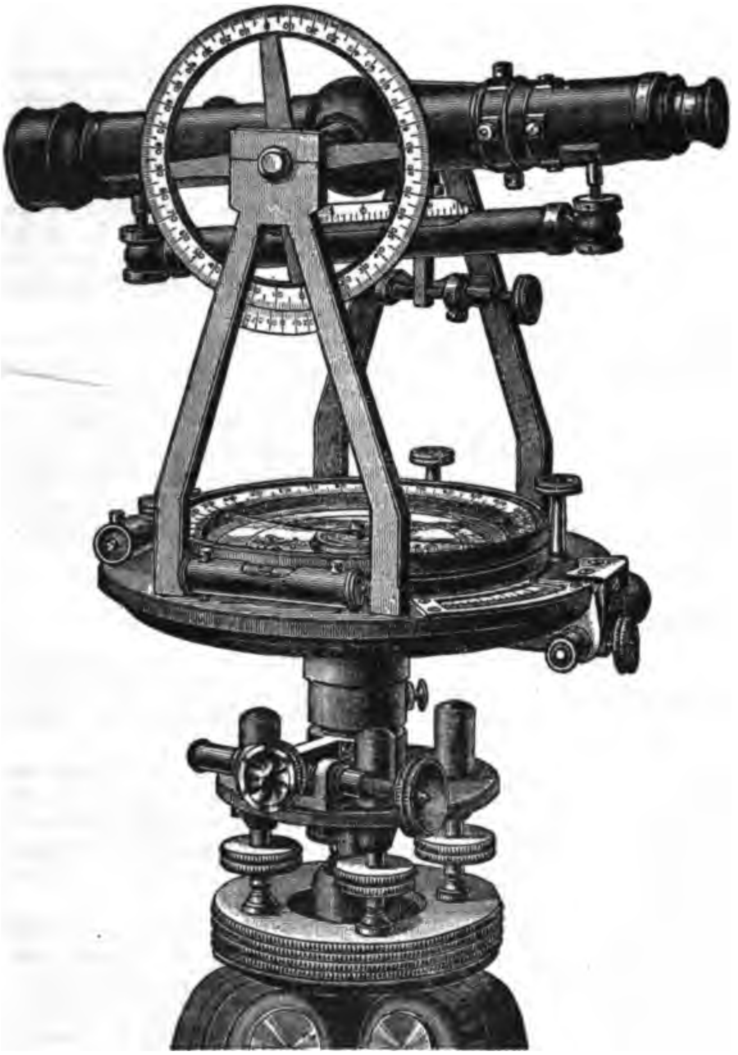


FIG. 62.

411. The instrument being in adjustment, to observe angles it should be set up, leveled, and focused. This involves placing the tripod so that a plumb bob from the center of the instrument shall hang directly over the spot at which the measurement is to be made. The legs of the tripod should be firmly placed in such manner that the height shall be convenient for the observer and the instrument shall be nearly level. Then the horizontal plates are brought to a true level by means of the leveling screws and bubbles. The telescope should next be focused by moving the object glass and eyepiece in such manner that the object sighted and the cross hairs may be plainly seen and that the object will not appear to have motion relatively to the cross hairs as the eye is moved to the right or left of the eyepiece. This last condition insures the cross hairs being at the common focus of the eyepiece and objective.

To observe a horizontal angle with a theodolite or transit, clamp the upper plate to the lower at zero, leaving the lower plate unclamped; swing the telescope so that its vertical cross hair bisects one of the objects, and clamp the lower plate; unclamp the upper plate and bring the telescope to bisect the other object, and the reading of the vernier on the scale will give the required angle. (The final nice motion by which the cross hair is brought exactly upon a point is always given by the tangent screw.)

In taking a *round of angles*, this operation is repeated successively upon each object to be observed about the horizon, the upper plate always being swung, while the lower is kept where set upon the first object, or *origin*. The result will give the angular distance of each object from the origin, and, if the observations have been accurately made, upon finally sighting back to the origin, the reading should be zero.

To *repeat an angle*, having made the first measurement of it in the usual way, unclamp the lower circle and swing back the telescope until it again points to the first object, and clamp it; then unclamp the upper circle, swing to the second object, and clamp. The scale reading should now be double that of the first angle. Repeat as often as the importance of the angle requires, and the accepted value will be the final reading divided by the number of measurements. All angles of the main triangulation, and others of importance in the survey, are repeated.

Defects in adjustment of the instrument may be eliminated by taking one series of angles with the *telescope direct* and another with the *telescope reversed*. To reverse the telescope, revolve it about its horizontal axis through 180°, then swing it about its vertical axis through 180°—in other words, invert it.

Vertical angles are measured on the same principle as that described for horizontal ones.

The process of setting up the instrument at a station and observing the angles between the various objects that are visible is called *occupying* the station.

412. The Plane Table.—This is an instrument by which positions are plotted in the field directly upon a working sheet. It consists (fig. 63) of a drawing board mounted upon a tripod in such manner as to be capable of motion in azimuth, and with facilities for being brought to a perfect level; in connection with it is employed an alidade, consisting of a straightedge ruler, upon which is mounted a telescope with cross hairs whose line of sight is exactly parallel to the vertical plane through the edge of the rule. It is evident that if a sheet representing a chart be placed upon such a board and turned so that the true meridians, as portrayed thereon, lie in the direction of the earth's meridian at that place, then all lines of bearings on the chart will coincide with the corresponding lines on the earth's surface; from which it follows that if the alidade be so placed that its rule passes through the spot on the chart representing the position of the observer, while the telescope is directed to some visible object, the position of that object on the chart lies somewhere upon the line drawn along the edge of the rule. Upon this general principle depend the various applications of the plane table.

The drawing board is usually made of several pieces of well-seasoned wood, tongued and grooved together, with the grain running in different directions to prevent warping; about its edge are several metal clips for securing the paper in place. It is supported upon three strong brass arms, to which it is attached by screws, thus permitting its removal at will. The arms are attached to a horizontal plate which revolves upon a second horizontal plate lying immediately below it; a clamp and tangent screw are fitted, by which the upper plate, and with it the drawing board, may be secured to the lower plate, or may be given a fine motion in azimuth. Three equidistant lugs of brass, grooved on the under side, project down from the lower plate, resting on screws in the top of the tripod, by which the instrument is leveled; when adjusted in this respect it is firmly clamped in position, and, as the tripod is made unusually large, the adjustment is not easily deranged.

The alidade is a metal straightedge with a vertical column at its center, at the top of which are the supports which carry the telescope; a vertical arc and vernier are provided for measuring the motion of the telescope in altitude. The telescope is usually so fitted that it may be revolved in azimuth through an arc of exactly 180°, for the purpose of adjusting the line of collimation. On top of the rule near its center is the level—sometimes replaced by two levels at right angles—by means of which it may be seen when the table is in a true horizontal position.

A magnetic needle mounted in a rectangular metal box, whose outer straightedge is parallel to the zero line of a graduated scale over which the needle swings, is provided for drawing the north-and-south line on the chart; this is called a *declinatoire*.

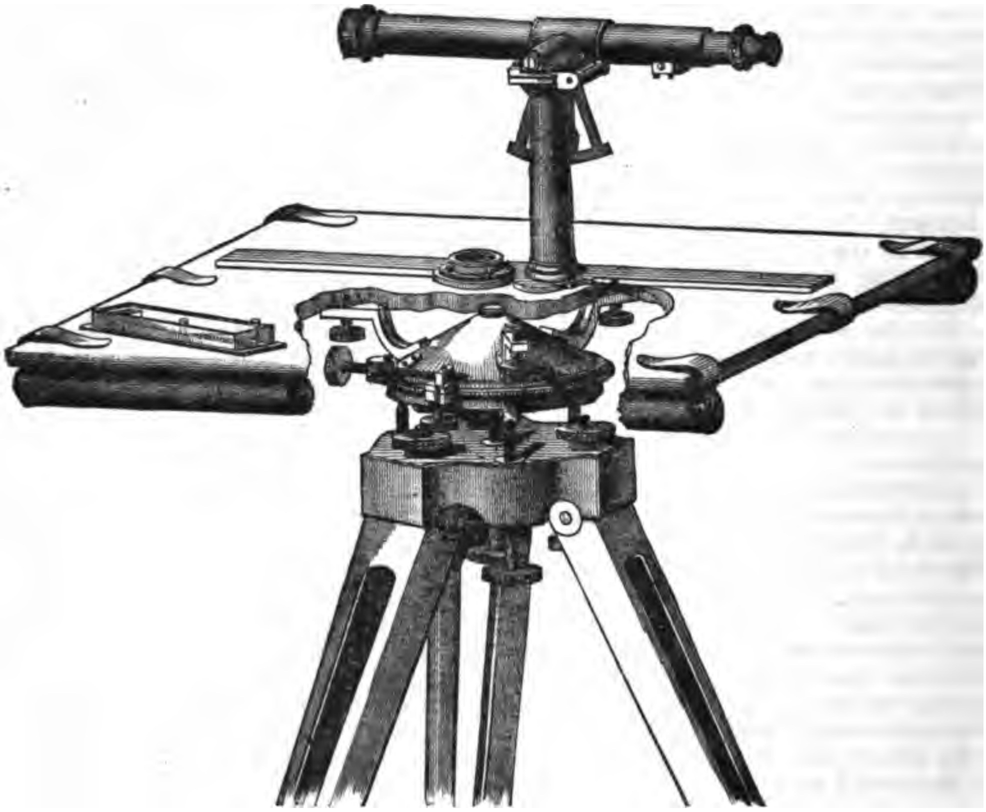


FIG. 63.

413. To be in correct adjustment, a plane table must comply with the following conditions:

(*a*) The fiducial edge of the rule must be perfectly straight. (*b*) The level must have the bubble in its central position when the table is truly horizontal. (*c*) The vertical cross hair must be perpendicular to the horizontal axis of the telescope. (*d*) The line of collimation must coincide with the line of sight. (*e*) The horizontal axis of the telescope must be parallel to the plane of the table. (*f*) The vertical circle should read zero when the line of collimation is horizontal.

414. The results derived from the use of the plane table, like all others dependent upon graphic methods, must be regarded as less accurate than those deduced by computation, and even less accurate than those derived from the careful plotting of theodolite angles. Hence it is that, in a careful marine survey, this instrument would be employed only for the topography and shore line.

For whatever purpose used, the plane table would not ordinarily be called into requisition until the survey had so far progressed that a chart could be furnished the observer showing certain stations whose positions were already established; with this chart, the first step would be to *occupy* one of the determined points. The table must be set up with the point on the chart directly over the center of the station; it must then be leveled and the telescope focused as described for the theodolite or transit; and finally it must be *oriented*—that is, so turned in azimuth that all lines of the chart are parallel to similar lines of the earth's surface. To orient, unclamp the table and swing it until the north-and-south line of the chart is approximately parallel to that of the earth, one means of doing which is afforded by the declinatoire; place the alidade so that the edge of the rule passes through the points on the chart representing the station occupied and some second station which is clearly in view; then, sighting through the telescope, perfect the adjustment of the table by swinging it until the second station is exactly bisected by the vertical cross hair, the final slow motion being obtained by clamping the table and working the tangent screw. If the adjustment has been correctly made, the rule may be laid along the line joining the station occupied and any other on the chart, and the telescope will point exactly to that other station.

Being properly oriented, if the alidade be so placed that the edge of the rule pass through the station occupied and the telescope point directly to some unknown object whose position is to be determined, then a line drawn along the rule will contain the point which represents the position of that object. If, now, the plane table be set up at a second station, oriented for its new position, and a line be similarly drawn from that station toward the one to be established, it will intersect the first line in the required point. This is the method of determining positions by *prosection*. Actually, the surveyor does not regard the point as well established until the intersection is checked by a line from a third station.

In practical work, of course, each station is not occupied separately for the determination of each point; the instrument is set up at a station, lines are drawn to all required points in view, and each line is appropriately marked; then a second station is occupied, and the operation is repeated, and so on, the various intersections being marked as the work proceeds.

A second method of establishing positions is that of *resection;* in this the first line is drawn from some known station, as in the preceding method, and the observer next proceeds to the place whose position is required and occupies it; the plane table is there oriented by means of the line already drawn, placing the edge of the rule along the line, sighting back toward the first station, and swinging the table until that station is in the line of sight of the telescope; then choose some other established station as nearly as possible at right angles to the direction of the first; place the edge of the rule upon the plotted position of this station and swing the alidade (the rule always being kept on the plotted point) until the object is bisected by the telescope cross hairs; draw this line, and its intersection with the first will give the required point, the accuracy of which can be checked from some other plotted station.

A third method of locating a point is by means of a single bearing from a known station, with the distance from the occupied station to the required one, the process of plotting being self-evident.

A fourth method is given by occupying an undetermined position from which three established stations are in view; the point occupied by the observer is then plotted by an application of the "three-point problem."

415. It may be seen that where the greatest accuracy is not essential the plane table may be employed for plotting all the points of a survey. In such a case it would only be necessary to begin with the two base stations, plotted on the sheet on any relative bearing whatsoever and at a distance apart equal to the length of the base line (reduced to scale), as measured by the most accurate means available. The work of plotting might even proceed before the base line had been measured, the two stations being laid off at any convenient distance apart; when later the base line was measured, the scale of the chart would be determined, being equal to the distance on the chart between base stations divided by the length of the base line.

416. A plane table could be improvised on shipboard which would greatly facilitate the operation of any surveying work that a vessel not equipped with instruments might be called upon to perform. A drawing board could be mounted upon a tripod (as, for example, the tripod supplied for compass work on shore) in such manner as to be capable of motion in azimuth; it could be brought nearly to the horizontal, if no better means offered, by moving the tripod legs, and this adjustment could be proved by any small spirit level; sight vanes could be erected upon an ordinary ruler to take the place of the alidade; in case there was difficulty in observing any object with such an alidade, because of its altitude or for other reasons, a horizontal angle might be observed with a sextant and plotted with a protractor. By this means work could be done which, even if it should lack complete accuracy, might be of great value.

417. The Telemeter and Stadia.—Any telescope fitted with a pair of horizontal cross hairs at the focus may be used as a *telemeter*, and when accompanied by a graduated staff, called a *stadia*, affords a means of measuring distance (up to certain limits) with a close degree of accuracy; the method consists in observing the number of divisions of the scale subtended by the hairs when the stadia is held perpendicular to the line of sight of the telescope, it being evident that the closer the distance the fewer divisions will appear between them. The facility with which distances can be measured by this method makes it most important that all telescopes of theodolites, transits, and plane tables be fitted as telemeters and that stadia rods be provided for all surveying work.

Speaking approximately, it may be said that the number of divisions intercepted between the cross hairs will vary directly as the distance of the stadia rod. This would be exactly true if we looked at the object through an empty tube, directly between the hairs. Since, however, the rays from the stadia are refracted by the object glass before they are intercepted by the wires, the statement, to be absolutely exact, must be slightly modified; but for practical surveying work it may be accepted as given.

418. There are two methods of installing the telemeter cross hairs—the first, in which they are immovably secured in the telescope and always remain at the same distance apart, and the second, in which the distance of the cross hairs is made variable, being under the control of the observer. The former is generally regarded as the preferable method, and when it is employed it is evident that the subtended height of the stadia bears a constant ratio to the distance of the staff from the telescope. It proves most convenient in practice to space the hairs so that this constant ratio is some even multiple of 10, for facility in converting scale readings into distance; it is also advantageous to mark the stadia in the unit of the chart scale and decimals thereof; for example, if the ratio of stadia height to distance were 100, and the stadia were marked in meters and decimals, a reading of 2.07 would at once be converted into a distance of 207 meters. Any units and any ratio may, however, be employed, and for any given setting of cross hairs it is very easy to graduate a stadia, by experiment, for any desired units; for example, if it is required to mark the stadia in feet, set up and level the telescope, measure off a distance of exactly 100 feet from it, hold up an unmarked staff and mark upon it the points intersected by the cross hairs; the interval between these marks will represent 100 feet of the scale; divide this length into 100 parts, each of which will represent a distance of one foot, and mark the whole staff on the same scale; then if the stadia be held up at any distance, the cross hairs will intercept a number of divisions corresponding to the number of feet of distance.

When the cross hairs are movable the ratio becomes variable, but the principle of measuring remains the same—namely, the distance of the staff from the telescope is equal to the existing ratio multiplied by the distance intercepted on the scale.

419. The stadia is made of a light, narrow piece of wood and is usually hinged for convenience in transporting. Ordinarily the background of the scale is painted white, while the main divisions are marked in red, with minor divisions in black, and geometrical figures are employed to facilitate the reading of fractional parts of the scale. Devices are furnished by which the man holding the stadia may know when it is vertical—an essential condition for accuracy of measurements.

420. The use of the telemeter and stadia for measuring distances is limited to the distance at which the scale divisions can be accurately read through the telescope. For fairly close work and with the class of telescope usually supplied with surveying instruments, 400 meters represents about the greatest distance at which it can be employed. With this limitation, the character of the survey determines the nature of its employment. In a careful survey its greatest use would be in connection with the theodolite or plane table in putting in shore lines, contour lines, and topography generally. In a survey where only approximate results are sought it might afford the best means for the measurement of the base.

421. If the telemeter be applied to a theodolite, transit, or plane table which is fitted with a graduated vertical arc or circle, it is possible to measure the distance to the stadia not only in a horizontal but also in a vertical direction. In this case the vertical angle must be observed as well as the stadia reading. Tables are computed giving the solution of the triangles involved when the stadia rod is held vertical.

422. In making a survey with the ordinary resources of a ship, the principle of the telemeter and stadia may be profitably employed, using a sextant and improvised staff. In this case it is usual to have the stadia of some convenient fixed length—as, for example, 10 feet—and of slight width and thickness; this is held at right angles to the line of sight from the observer, who notes the angle subtended by the total length; tables are prepared by which the distance corresponding to each angle is given.

423. THE SEXTANT.—This instrument is of the greatest value in hydrographic surveying. It is fully described elsewhere in this work and its adjustment explained. (Chap. VIII.)

Sextants are manufactured of a form especially adapted to surveying work; they are smaller and lighter than those usually employed in astronomical observations, but have a longer limb, by which angles may be measured up to 135°; the vernier is marked for quick reading and has no finer graduation than half minutes; the telescope has a large field.

This instrument is principally employed in measuring the horizontal angles by means of which soundings are plotted. It may, however, be put to various uses when making an approximate survey, as has already been explained. It should be remembered, in measuring terrestrial angles with a sextant, that rigorous methods require a reduction to the horizontal if either of the objects has material altitude above the horizon.

424. THE LEVEL.—This is an instrument for the accurate measure of differences of elevation. It consists of a telescope, carried in a Y-shaped rest, which is mounted upon a tripod and leveled in a manner similar to a theodolite; but it differs from that instrument in that the telescope is not capable of motion about a horizontal axis and in having no graduated circles for measurements of altitude and azimuth. The principle of its use contemplates placing the line of collimation of the telescope in a truly horizontal plane and keeping it so fixed.

425. It is principally employed in marine surveying to determine heights and contour lines—the latter being lines of equal elevation above the sea level—and for locating bench marks for tidal observations. (Chap. XX.) In connection with it is used a graduated staff called a *leveling rod*, carrying a conspicuous mark, adjustable in height, called a *target*. To ascertain the difference of level between any two points, set up the level with the telescope horizontal at some place between them; let an assistant take the leveling rod to one of the points, and, while holding it on the ground in a truly vertical position, move the target, under the direction of the observer at the telescope, to a point where it is exactly bisected by the horizontal cross hair; the height of the target on the staff—that is, the height of the cross hair above the level of the first point—is then accurately read with a vernier; now, without moving the level, shift the rod to the second point and again adjust the target and read it. It is evident that a comparison of the reading at the first position with that at the second will give the difference of height at the two points. The difference that can be read from one location of the instrument is limited by the length of the rod; but by making a sufficient number of shifts any difference may be measured.

The work of the level may be performed equally well by a theodolite whose telescope is adjusted to the true horizontal.

426. HELIOTROPE AND HELIOGRAPH.—These are instruments sometimes employed in surveying, by means of which the sun's rays may be reflected in any given direction; the object of their use is to render conspicuous a station which is to be observed at a distance and which would not otherwise be distinguishable. The instruments vary widely in form of construction and, in the absence of those made for the purpose, substitutes may easily be devised.

427. Astronomical Transit Instruments.—Various instruments are employed for the astronomical determinations necessary in a marine survey. Among these are the *zenith telescope* and *portable transit*. While differing in detail they consist essentially of a telescope mounted upon a horizontal axis that is placed truly in the prime vertical, thus insuring the revolution of the line of collimation in the meridian; a vertical graduated circle and vernier are supplied, affording a measure of altitude; in the focus are a number of equidistant vertical cross hairs or lines; a small lamp is so placed that its rays illuminate the cross hairs and render possible observations at night. Latitude is obtained by observing the meridian altitude of stars; hour angle (and thence longitude) by observing the times of their meridian transit, which is taken from the mean of the times of passing all of the vertical cross hairs.

Excepting in surveys of a most accurate nature, the astronomical determination of position by the sextant and artificial horizon is regarded as satisfactory.

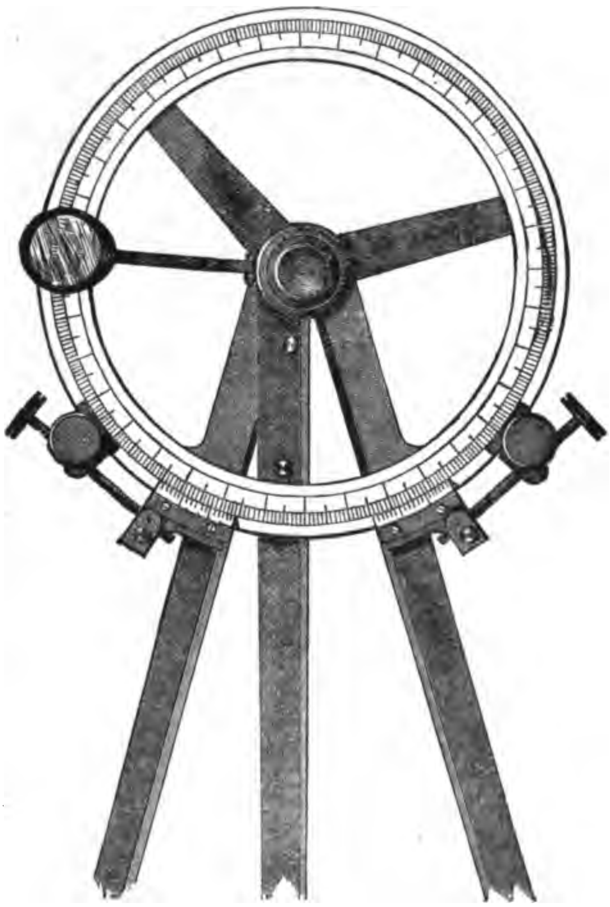


Fig. 64.

428. The Three-Armed Protractor, or Station Pointer.—This is an instrument whereby positions are plotted on the principle of the "three-point problem," of which an explanation is given in article 152, Chapter IV. It consists (fig. 64) of a graduated circle with three arms pivoted at the center; each arm has one edge that is a true rule, the direction of which always passes through the center of the circle. The middle arm is immovably fixed at the zero of the scale; the right and left arms each revolve about the center on their own sides, and are provided with verniers giving the angular distance from the middle arm. The protractor being set for the right and left angles, it is so moved that the three arms pass through the respective stations, when the center marks the position of the observer. Center pieces of various forms are provided, being cylindrical plugs made to fit into a socket at the pivot, and by employing one or the other of them the true center may be pricked with a needle, dotted with a pencil, or its position indicated by cross hairs. Adjustable arms are provided which can be fitted to the ends of the ordinary arms when working with distant signals.

The most valuable use of the three-armed protractor is in plotting the positions of soundings taken in boats, where sextant angles between signals are observed. It may occur, however, that certain shore stations will be located by its use.

429. As this instrument is not made with both right and left arms capable of being set to small angles down to 0°, the manufacturers make protractors with either small right or small left angles. Surveying parties should be equipped with both. In default of a three-armed protractor, a piece of *tracing paper* may be made to answer its purpose. To use the tracing paper, draw a line, making a dot on it to represent the center station, and with the center of an ordinary protractor on the dot, lay off the two observed angles right and left of the line; then, laying this on the plan, move it about till the three lines pass exactly through the three stations observed. The dot from which they were laid off will be on the position of the observer, and must be pricked lightly through or marked underneath in pencil.

430. The Beam Compass.—This instrument (fig. 65) is employed in chart drafting and performs the functions of compasses and dividers when the distance that must be spanned is beyond the limits of those instruments in their ordinary form. It consists of an angular bar of wood or metal upon which two instruments termed beam heads are fitted in such a manner that the bar may slide easily through them. A clamping screw attached to one side of the beam head will fix it in any part of its course along the beam. Upon each head a socket is constructed to carry a plain point, exchangeable for an ink or a pencil point. To secure accuracy the beam head placed at the end of the beam has a fine adjustment, which moves the point a short distance to correct any error in the first rough setting of the instrument. This adjustment generally consists of a milled-head screw, which passes through a nut fixed upon the end of the beam head, which it carries with its motion.

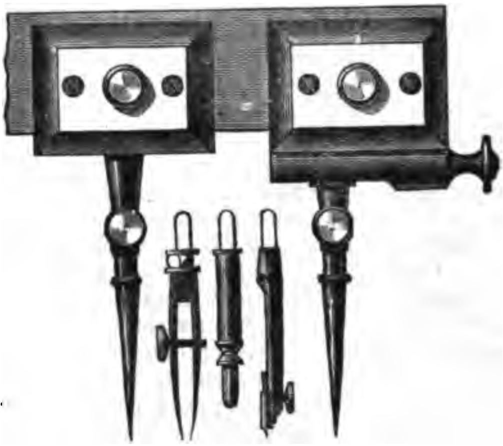


Fig. 65.

431. Proportional Dividers.—These are principally employed for reducing or enlarging drawings in any given proportion. They consist (fig. 66) of two narrow flat pieces of metal called *legs*, which turn upon a pivot whose position is movable in the direction of their length. The ends of both legs are shaped into points like those of ordinary dividers. When the pivot is fixed at the middle of the legs, any distance measured by the points at one end is just equal to that measured by those at the other; for any other location of the pivot, however, the distances thus measured will not be equal, but with a given setting of the pivot any distance measured by one end bears a fixed ratio to that measured by the other. The path of travel of the pivot is graduated so that the ratio may be given any desired value. Being adjusted in this respect, if a distance is taken off a chart with the legs at one end of the instrument, then those at the other end will show the same distance on the scale of a chart enlarged or reduced in the proportion represented by the ratio for which the pivot was set.

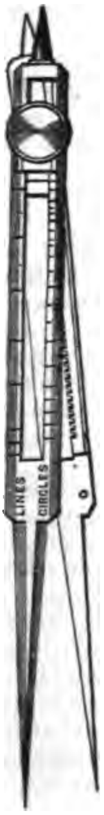


Fig. 66.

METHODS EMPLOYED IN A HYDROGRAPHIC SURVEY.

432. Before commencing a survey a general inspection of the field is made; a *base line* is located and its extremities marked by *signals*; certain other positions, known as *main triangulation points*, are selected and also marked with signals, being so chosen that, starting with the base and proceeding thence from one to another of these points, a series of well-conditioned triangles or quadrilaterals may cover the field of survey. The base line is measured with the greatest degree of accuracy which the resources of the survey render possible. Each extremity of the base line and each other main triangulation point is occupied by an observer with a theodolite, who measures the angles at each station between all the other stations which are in sight. An *astronomical determination* is made of the latitude and longitude of some point of the survey (frequently one of the extremities of the base) and of the true azimuth of some known line (frequently the base line). Data are now at hand for the location upon the chart of the base line and main triangulation points.

If the survey is one of considerable extent, it is expedient to measure a *check base* near the end of the triangulation. A comparison between the measured length of this base and its length as computed through the chain of triangles will show the degree of accuracy and afford a means of reconciling discrepancies. The position of a second observation spot may be determined for a similar purpose.

The *primary triangulation* gives a skeleton of the field, but the points thus determined are not usually close enough together to afford a basis for all the detail work that must be done. A second system of points is therefore selected and signals erected thereon, and the position of these points is determined by a series of angles from the main triangulation points and from one another. This is known as the *secondary triangulation.* The points thus located are used in the plotting of the *topography* and *hydrography.* It is not essential that their determination be as accurate as that of main triangulation points.

The topography is put in, and includes the delineation of the features of the land—shore line, lighthouses, beacons, contour lines, peaks, buildings, and, in short, everything that may be recognized by the navigator and utilized by him in locating the ship's position.

The hydrographic work is taken up and the depth of water and character of bottom determined as accurately as possible for the complete water area, especial care being taken to develop all shoals and dangers to navigation and to locate all aids to navigation, such as buoys, lightships, and beacons.

One or more *tidal stations* are established where observations are taken, continually and at frequent intervals, of the height of the tide and direction and velocity of the tidal and other currents, whence data are derived for the reduction of all soundings to the plane of reference and for the information about tides and currents which is to appear upon the chart.

Observations are made to determine the *magnetic* variation and dip, and the intensity of the earth's magnetic force.

433. The foregoing represent, in outline, the various steps that must be taken in the accumulation of the data necessary for the construction of a complete hydrographic chart. In the following paragraphs the details of the various operations will be more fully set forth.

The navigator who is called upon to conduct a marine survey without having available the time, instruments, and general facilities necessary for the most thorough performance of the work must exercise his discretion as to the modifications of method that he will make, and call upon his ingenuity to adapt his means to the particular work in hand.

434. THE BASE LINE.—As the base line is the foundation for all distances on the chart, the correctness of the results of the survey will depend largely upon the degree of accuracy with which it is measured. The triangulation merely affords a measure of the various distances as compared with the distances between the two initial points from which it began; if that initial distance is 1,000 feet, we have certain values for the sides of the various triangles; if the same base line is 2,000 feet, the value of each side becomes twice as great as it was before; with the same triangulation, therefore, distances vary directly with the length of the base line; it may thus be seen that if an error exists in measurement which is only a small fraction of the total length, the error will become much more material as the more distant points of the survey are reached. In a base line 1,000 feet long, if a mistake of 10 feet be made all distances measured upon the chart will be in error 1 per cent, and a point plotted by triangulation 10 miles from the observation spot (the point at which plotting begins), would be out of its correct position one-tenth of a mile.

It is important that the base line should be as long as possible, consistent with the distribution and distances between the surrounding objects which must be depended upon as triangulation stations for its expansion. The position of the line must be such as to afford favorably conditioned triangles and quadrilaterals with adjoining main triangulation points, and its extremities must be visible from those points and from each other. The character of the ground and the facility for measuring will of course form an important consideration in the choice.

435. In measuring a base by tape, chain, or similar means, a number of successive fleets are made with the measure, whatever its nature, the distance traversed being appropriately marked after each fleet, while an observer, with a theodolite or transit, insures the measurement being made accurately along the line.

436. The most careful measurements are made with a steel tape 300 feet long, stretched along a series of supports at equal intervals along the base line, the points of support being made exactly horizontal by a level. A good form of support is a stake driven vertical with one side on the base line and a nail, for supporting the tape, driven horizontally into the stake at the established level. The stakes falling at the ends of tape lengths should be set slightly less than 300 feet apart, sawed off at the established level, and have strips of zinc tacked on their tops. The end of each fleet is marked by a scratch mark cut in the strip of zinc at an even hundredth of a foot-division on the tape, and the corresponding tape reading recorded. Tapes for base-line measurement are usually subdivided to hundredths of a foot for a distance of 10 feet from each end of the tape. The tape is stretched to a uniform tension by a spring balance. The temperature of the tape at each fleet should be observed, and the mean temperature, for the entire measurement of the base deduce. Tapes for base-line measurements are usually standardized lying flat, and at a temperature of 62° Fahrenheit. To reduce the measured length of the base line to the true length the following corrections to the measured length must be applied:

Temperature correction $C_t = +(\alpha T_m - T_o)\,L$,
where α = coefficient of expansion.
T_m = mean temperature at measurement.
T_o = standard temperature.
L = measured length.

Correction for sag $C_s = -\frac{L}{24}\left(\frac{wd}{P}\right)^2$.
where L = measured length.
w = weight per inch of tape.
d = distance between supports in inches.
P = tension in pounds.

By this method of measurement the horizontal distance between the ends of the base line may be readily found to within 1 part in 250,000, and by application of superior apparatus, of several measures, and greater care—hence, at an increased cost—the probable uncertainty may be reduced to 1 part in 500,000, but this degree of accuracy would not be necessary except in very extended systems of triangulation.

437. A second method of base measurement is with the surveyor's chain. This depends for accuracy upon the surface traversed being plane and level, a condition that is well fulfilled on a sandy beach, where the chain is nearly as accurate as the tape and much more rapid. A surveyor's chain is usually 100 feet long; the exact value of its length must be obtained by comparison with a standard, and a correction applied for expansion or contraction due to temperature. The ends of the fleets are marked by steel pins driven into the ground; the alignment is kept by the theodolite.

438. Where neither chain nor tape is available substitutes may be improvised from sounding wire taken from the deep-sea sounding machine, or failing this, from well-stretched cod line.

Measurements made by the telemeter and stadia afford a close approximation to the true result, and if these instruments are not at hand the sextant angle of a rod of fixed length can be employed. The masthead height of the vessel may be used in determining the length of base line on this principle, either by making the ship itself mark one of the extremities and observing the masthead angle from the other extremity, or by simultaneously observing the masthead angle from both ends of a shore base, and also the three horizontal angles of the triangle formed by the ship and the two base stations. The latter plan is far preferable where accuracy is sought, as, if the angles are all taken by different observers at the same instant (which can be marked by the hauling down of a flag), the error arising from the motion of the ship about her anchor is eliminated, and, moreover, the data furnished offers a double solution of the triangle and the mean may be taken as giving a closer result.

439. A crude method of estimating distance is by means of the velocity of sound, though this would never be used where close results are expected. Fire a gun at one end of the distance and at the other note by the most accurate means available the time between seeing the flash and hearing the report. Repeat several times in each direction. The mean number of seconds and tenths of a second multiplied by the velocity of sound per second at the temperature of observation (art. 314, Chap. XI) gives the approximate distance.

440. When for any reason the existing conditions do not permit of a direct measurement being made along the line between the two base stations, recourse must be had to a *broken base,* that is, one in which the length of the base is obtained by reduction from the measured length of two or more auxiliary lines. Necessity for resorting to a broken base arises frequently when the two stations are situated on a curving shore line and the straight line between them passes across water, or where wooded or unfavorable country intervenes, or where a stream must be crossed. The most common form of broken base is that in which the auxiliary lines run from each extremity of the base at an acute angle and intersect; in addition to measuring each of these lines the angle formed by their intersection or else the angles formed by them with the base line must be observed and the true length of the base deduced by solution of the triangle. The form that is most frequently used where only a short section of the base is incapable of measurement (as is the case where a deep stream flows across) is that of an auxiliary right triangle whose base is the required distance along the base line and altitude a distance measured along a line perpendicular thereto to some convenient point; by this measured distance and the angles which are observed, the triangle is solved and the length of the unmeasured section determined.

441. In a survey of considerable extent, where good means are at hand for the correct determination of latitude and longitude, a base line actually measured upon the earth may be dispensed with, and, instead of that, the positions of the two stations which are most widely separated may be determined astronomically and plotted; the triangulation is then plotted upon any assumed scale, and when it has been brought up to connect the two stations the true value of the scale is ascertained. This is called the method of an *astronomical base.*

442. SIGNALS.—All points in the survey whose positions are to be located from other stations, or from which other positions are to be located, must be marked by signals of such character as will render them distinguishable at the distance from which they are observed. The methods of constructing signals are of a wide variety.

A vessel regularly fitted out for surveying would carry scantlings, lumber, bolts, nuts, nails, whitewash, and sheeting for the erection of signals; however meager the equipment, the whitewash and sheeting (or some substitute for sheeting, preferably half of it white and half dark in color) should be provided, if possible, before beginning any surveying work. Regular tripod signals, which are quickly erected and are visible, under favorable circumstances, for many miles, are almost invariably employed to mark the main triangulation stations; among other advantages the tripod form permits the occupation with the theodolite of the exact center of the station, and avoids the necessity for the reduction which must otherwise be applied. Signals on secondary stations take an innumerable variety of forms, the requirement being only that they shall be seen throughout the area over which they are to be made use of; a whitewashed spot on a rock, a whitewashed trunk of a tree, a whitewashed cairn of stones, a sheeting flag, a piece of sheeting wrapped about a bush, or hung, with stones attached, over a cliff, or a whitewashed barrel or box filled with rocks or earth and surmounted by a flag, suggest some of the secondary signals that may be employed; sometimes objects are found that are sufficiently distinct in themselves to be used as signals without further marking, as a cupola or tower, a hut, a lone tree, or a bowlder; but it is seldom that an object is not rendered more conspicuous by the flutter of a flag above it, or by the dead-white ray reflected from a daub of whitewash.

For convenience, each signal is given some short name by which it is designated in the records.

For the sake of economy in both time and labor, steel towers, such as are used to support windmills, are being extensively employed by hydrographic parties for survey signals. They are very easily erected and dismounted, easily transported, offer little resistance to gales of wind, and are more permanent and satisfactory than signals of wood.

443. THE MAIN TRIANGULATION.—The points selected as stations for the main triangulation mark in outline the whole area to be surveyed; they are close enough together to afford an accurate means of plotting all intermediate stations of the secondary triangulation; and they are so placed with relation to one another that the triangles or quadrilaterals derived from them are well conditioned. The points are generally so chosen that small angles will be avoided. In order to fulfill the other conditions, it frequently becomes necessary to carry forward the triangulation by means of stations located on points a considerable distance inland, such as mountain peaks, which would not otherwise be regarded as properly within the limits of the survey.

Great care should be taken in observing all angles upon which the main triangulation is based; the best available instrument should be employed; angles taken with a theodolite or transit should be repeated, and observed with telescope direct and reversed, and the mean result taken; if the sextant is used, a number of separate observations of each angle should be taken and averaged for the most probable value. It must be remembered that while, in any other part of the work, an error in an angle affects only the results in its immediate vicinity, an error in the main triangulation goes forward through all the plotting that comes after it.

It occurs frequently that the purposes of the survey are sufficiently well fulfilled by a graphic plotting of the main triangulation, but where more rigorous methods prevail, the results are obtained by calculation. The sum of the angles of each triangle is taken, and if it does not exactly equal 180° the values are adjusted to make them comply with this condition. In cases where the triangulation stations form a series of quadrilaterals, the angles of each quadrilateral are adjusted so as to form a perfect geometrical figure. Allowance is made for the curvature of the earth where the area of triangles is sufficiently large to render it expedient to do so. The lengths of the various sides and the relative latitudes and longitudes of the several stations are then computed. Each station may then be plotted in its latitude and longitude on a polyconic projection, and a delineation of the triangulation system may thus be obtained free from the accumulated errors of a graphic plotting.

444. THE SECONDARY TRIANGULATION.—The points of the secondary triangulation are located, as far as possible, by angles from the main triangulation stations; these angles, having less dependent upon them, need not be repeated. A graphic plotting of these stations, without calculation, will suffice.

445. ASTRONOMICAL WORK.—This comprises the determination of the correct latitude and longitude of some point of the survey, and of the true direction of some other point from the observation spot, thus furnishing an origin from which all positions and all directions can be determined either graphically or by computation.

The methods of finding latitude, longitude, and the true bearing of a terrestrial object are fully set forth in previous chapters. The feature that distinguishes such work in surveying from that of determining the position of a ship at sea lies in the greater care that is taken to eliminate possible errors.

The results should therefore be based upon a very large number of observations, employing the best instruments that are available, and the various sights being so taken that probable errors are offset in reckoning the mean.

446. By taking a number of sights the observer arrives at the most probable result of which his instruments and his own faculties render him capable; but this result is liable to an error whose amount is indeterminate and which is equal to the algebraic sum of a number of small errors due, respectively, to his instruments (which must always lack perfection in some details), to an improper allowance for refraction under existing atmospheric conditions, and to his own personal error. Assuming, as we may, that the personal error is approximately constant, these three causes give rise to an error by which all altitudes appear too great or too small by a uniform but unknown amount. Let us assume, for an illustration, that this error has the effect of making all altitudes appear 30″ too great; if an observer attempted to work his latitude from the meridian altitude of a star bearing south, the result of this unknown error would give a latitude 30″ south of the true latitude;

if another star to the southward were observed, this mistake would be repeated; but if a star to the north were taken, the resulting latitude would be 30″ to the north. It is evident, therefore, that the true latitude will be the mean of the results of observation of the northern and the southern star, or the mean of the average of several northern stars and the average of several southern stars. A similar process of reasoning will show that errors in the determination of hour angle are offset by taking the mean of altitudes of objects respectively east and west of the meridian.

447. It must be remembered that the uniformity of the unknown error only exists where the altitude remains approximately the same, as instrumental and refraction errors may vary with the altitude; another condition of uniformity requires that the instrument and the observer remain the same, and that all observations be taken about the same time, in order that atmospheric conditions remain unchanged; to preserve uniformity, if the artificial horizon is used, the same end of the roof should always be the near one to the observer; in taking the sun, however, as the personal error may not be the same for approaching as for separating limbs, every series of observations should be made up of an equal number of sights taken under each condition.

448. With all of this in mind, we arrive at the general rule that astronomical determinations shall be based upon the mean of observations, under similar conditions, of bodies whose respective distances from the zenith are nearly equal, and which bear in opposite directions therefrom.

449. This condition eliminates the sun from availability for observations for latitude, though it properly admits the use of that body for longitude where equal altitudes or single a. m. and p. m. sights are taken. Opposite stars of approximately equal zenith distance should always be used for latitude, circum-meridian altitudes being observed during a few minutes before and after transit; excellent results are also obtained from stellar observations for longitude; but very low stars should be avoided, on account of the uncertainty of refraction, and likewise very high ones, as the reflection from the index mirror of the sextant may not be perfectly distinct when the ray strikes at an acute angle.

If there is telegraphic or radio communication, an endeavor should be made to obtain a time signal from a reliable source, instead of depending upon the chronometers.

450. TOPOGRAPHY.—The plane table, with telemeter and stadia, affords the most expeditious means of plotting the topography, and should be employed when available. Points on shore may also be plotted by sextant angles, using the three-point problem, or by any other reliable method.

451. HYDROGRAPHY.—The correct delineation of the hydrographic features being one of the most important objects of the survey, great care should be devoted to this part of the work. Soundings are run in one or more series of parallel lines, the direction and spacing of which depend upon the scope of the survey. It is usual for one series of lines to extend in a direction normal to the general trend of the shore line. In most cases a second series runs perpendicular to the first, and in surveys of important bodies of water still other series of lines cross the system diagonally. In developing rocks, shoals, or dangers the direction of the lines is so chosen as will best illustrate the features of the bottom. When lines cross, the agreement of the reduced soundings at their intersection affords a test of the accuracy of the work.

As the depth of water increases, if there is no reason to suspect dangers, the interval between lines may be increased.

Lines are run by the ship or boat in such manner as to follow as closely as possible the scheme of sounding that has been laid out. The position is located by angles at the beginning of each line, at each change of course, at frequent intervals along the line, and at the point where each line is finished. Soundings taken between *positions* are plotted by the time intervals or patent log distances.

452. There are a number of methods for determining positions while sounding, which may be described briefly as follows:

By two sextant angles.—Two observers with sextants measure simultaneously the angles between three objects of known position, and the position is located by the three-point problem. This is the method most commonly employed in boat work, and has the great advantage that the results may be plotted at once on the working sheet in the boat and the lines as run thus kept nearly in coincidence with those laid out in the scheme. A study of the three-point problem (art. 153, Chap. IV) will give the considerations that must govern in the selection of objects.

By two theodolite angles.—Two stations on shore are occupied by observers with theodolites, and at certain instants, indicated by a signal from the ship or boat, they observe the angular distance thereof from some known point. The intersection of the direction lines thus given is at the required position. This method is expeditious where the signals are small or not numerous. Its disadvantage is that the plotting can not be kept up as the work proceeds.

By one sextant and one theodolite angle.—An observer ashore occupies a station with a theodolite and cuts in the ship or boat, while one on board takes a sextant angle between two objects, of which one should preferably be the occupied station. It is plotted by laying off the direction line from the theodolite and finding with a three-armed protractor or piece of tracing paper at what point of that line the observed angle between the objects is subtended. Its advantages and disadvantages are the same as those of the preceding method.

In running lines of soundings offshore, where signals are lost sight of, the best method is to get an accurate departure, before dropping the land, by the best means that offers, keeping careful note of the dead reckoning, and on running in again, to get a position as soon as possible, note the drift and reconcile the plotting of intermediate soundings accordingly. Where circumstances require, the position may be located by astronomical observations as usually taken at sea.

453. A careful record of soundings must be kept, showing the time of each (so that proper tidal correction may be applied), the depth, the character of bottom, and such data as may be required to locate the position.

454. THE WIRE DRAG.—The use of the lead in hydrographic surveying does not absolutely establish a definite available depth, as pinnacle obstructions may exist which are not detected by that means. This is particularly true of rocky localities and those of coral formation.

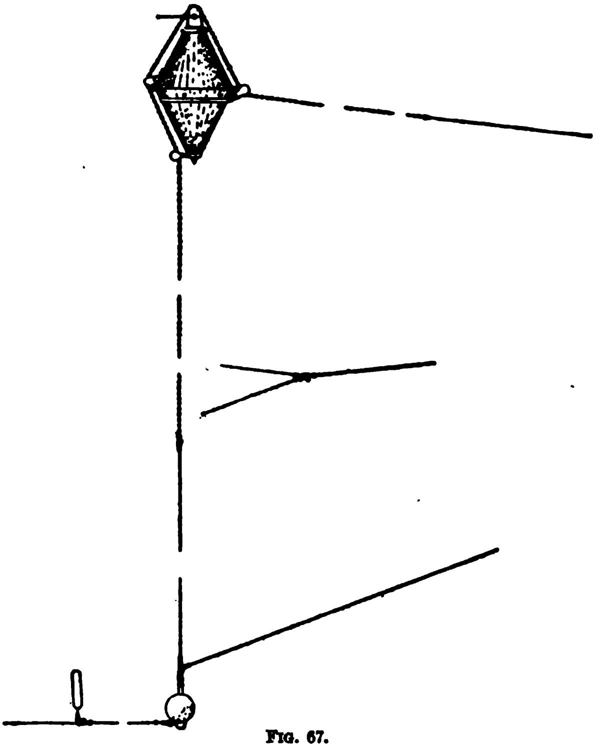


FIG. 67.

In order to guarantee a certain depth of water for purposes of navigation it has become the practice to tow through the waters to be examined a line of wire or cable suspended at that depth.

The drag or sweep consists essentially of a horizontal member, known as the bottom wire, which is a long steel line composed of 50-foot sections coupled together with swivels and shackles. It is supported at each terminal from an 80-pound buoy by a chain stirrup line whose length may be adjusted from 20 to 50 feet. There are smaller buoys placed at intervals varying from 150 to 450 feet, according to local conditions, which support the wire by means of steel-cable stirrup lines, adjustable in length like the chain stirrup lines on the terminal buoys. At intermediate 50-foot connections, cedar toggles or floats, which have a little more buoyancy than is sufficient to support the wire between the stirrup lines, are attached by means of snap hooks. To prevent the bottom wire from sagging back as the drag is towed transversely to its own length by the bridles fastened at the terminals, a leaden weight of 165 pounds is suspended from each of the terminal stirrup lines, and a weight of 20 pounds from each of the intermediate stirrup lines. The length of the drag may be varied through a wide range to suit the conditions existing in the localities to be examined. Any multiple of 50 feet may be used, but it is in general found best to use, in each division between two towing launches, eight sections with stirrup-line suppports at their ends, each composed of from three to seven 50-foot units. The towing launches use tow lines about 200 feet in length bridled to the terminal stirrup lines with attachments at the top and bottom. During the towing, as long as the drag is free, the line of supporting buoys will trace out a parabolic curve on the surface of the water; but, if progress should be interrupted by a pinnacle of rock rising in its path above the depth to which the drag line is set, the parabolic curve of the line of buoys will immediately become broken into the form of a V, whose angle will correspond in position with the position of the pinnacle. The presence of any such obstruction is also registered by the spring balance usually attached to the towline at a convenient position near the towing vessel. If the shape of the obstruction is such as to allow the drag line to ride upward upon it, as may be with bowlders and shoals, an additional indication of its presence is afforded by the falling over of the supporting buoys when the suspended stirrup lines are relieved of strain by the grounding of the weights attached to them.

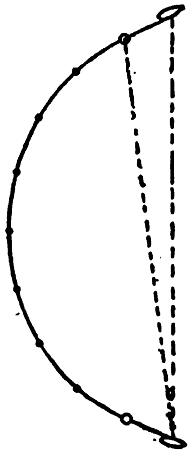


Fig. 68.

In such cases a tender should be in readiness to proceed to the indicated point for the purpose of taking position angles to locate the spot and also soundings to ascertain the characteristics of the obstruction. Such localities are plotted upon the chart upon which the paths of the drag line are being mapped, and later these areas are again swept with the drag line at a lesser depth; and this procedure is continued until the obstruction is cleared by the drag line, and thus the least depth is proved. The position of the drag is determined by observers with sextants on board the towing vessels who simultaneously measure, at frequent intervals, the values of two angles between two pairs of known objects whose positions are identified upon the plotting chart.

The average speed of towing is about 1½ knots per hour, and the average area explored per working day is 1½ square miles, although a much higher rate of progress is usually attained in open areas under favorable conditions.

455. Tidal Observations.—These should begin as early as practicable and continue throughout the survey, it being most important that they shall, if possible, cover the period of a lunar month. In the chapter on tides (Chap. XX) the nature of the data to be obtained is explained.

456. Magnetic Observations.—The feature of the earth's magnetism with which the navigator is most concerned is the variation, which is set forth on the chart, and upon the determination of which will depend the correctness of all courses and bearings on shipboard. It is usually obtained by noting the compass direction from the observation spot of the object whose true bearing is known by calculation, and comparing the true and compass bearings; or it may be observed by mounting the ship's compass in a place on shore free from foreign magnetic influence, and finding the compass error as it is found on board. Observations for dip and intensity are also made when the proper instruments are at hand.

457. Running Survey.—Where time and opportunity permit only a superficial examination of a coast line or water area, or where the interests of navigation require no more, recourse is had to a *running survey*, in which shore positions are determined and soundings are made while the ship steams along the coast, stopping only occasionally to fix her position, and in which the assistance of boat or shore parties may or may not be employed.

In this method the ship starts at one end of the field from a known position, fixed either by astronomical observations or by angles or bearings of terrestrial objects having a determined location. Careful compass bearings or sextant angles are taken from this position to all objects ashore which can be recognized, and a series of direction lines is thus obtained. The ship then steams along the coast, at a convenient distance therefrom, keeping accurate account of her run by compass courses and patent log. From time to time other series of bearings or angles are taken upon those objects ashore which are to be located, the direction lines plotted from the estimated position of the ship, and the various objects located by the intersections with their other direction lines. During all the time that the ship is under way, soundings are taken at regular intervals and plotted from the dead reckoning. As frequently as circumstances permit, the ship is stopped and her position located by the best available means, and the intervening dead reckoning reconciled for any current that may be found.

If a steam launch can be employed in connection with a running survey, it is usually sent to run a second line inshore of the ship. The boat's position is obtained by bearings of objects ashore which are located by the ship, or by bearings and masthead angles of the ship, or by such other means as offer. The duty of the boat is to take a series of soundings and to collect data for shore line and topography.

If circumstances allow the landing of a shore party, its most important duty is to mark the various objects on shore by some sort of signals which will render them unmistakable. Beyond this, it can perform such of the duties assigned to shore parties in a regular survey as opportunity permits.

CHAPTER XVIII.

WINDS.

458. *Wind* is air in approximately horizontal motion. Observations of the wind should include its true direction, and its force or velocity. The direction of the wind is designated by the point of the compass from which it proceeds. The force of the wind is at sea ordinarily expressed in terms of the Beaufort scale, each degree of this scale corresponding to a certain velocity in miles per hour, as explained in article 68, Chapter II.

459. The Cause of the Wind.—Winds are produced by differences of atmospheric pressure, which are themselves ultimately, and in the main, attributable to differences of temperature.

To understand how the air can be set in motion by these differences of pressure, it is necessary to have a clear conception of the nature of the air itself.

The atmosphere which completely envelops the earth may be considered as a fluid sea at the bottom of which we live, and which extends upward to a considerable height, probably 200 miles, constantly diminishing in density as the altitude increases.

The air, or material of which this atmosphere is composed, is a transparent gas, which, like all other gases, is perfectly elastic and highly compressible. Although extremely light, it has a perfectly definite weight, a cubic foot of air at ordinary pressure and temperature weighing 1.22 ounces, or about one seven hundred and seventieth part of the weight of an equal volume of water. In consequence of this weight it exerts a certain pressure upon the surface of the earth, amounting on the average to 15 pounds for each square inch. To accurately measure this pressure, which is constantly undergoing slight changes, we ordinarily employ a mercurial barometer (art. 48, Chap. II), an instrument in which the weight of a column of air of given cross section is balanced against that of a column of mercury having an equal cross section; and instead of saying that the pressure of the atmosphere is a certain number of pounds on each square inch, we say that it is a certain number of inches of mercury, meaning thereby that it is equivalent to the pressure of a column of mercury that many inches in height, and one square inch in cross section.

All gases, air included, are highly sensitive to the action of heat, expanding or increasing in volume as the temperature rises, contracting or diminishing in volume as the temperature falls. Suppose now that the atmosphere over any considerable region of the earth's surface is maintained at a higher temperature than that of its surroundings. The warmed air will expand, and its upper layers will flow off to the surrounding regions, cooling as they go. The atmospheric pressure at sea level throughout the heated areas will thus be diminished, while that over the circumjacent cooler areas will be correspondingly increased. As the result of this difference of pressure, there will be movement of the surface air away from the region of high pressure and toward the region of low, somewhat similar to the flow of water which takes place through the connecting bottom sluice as soon as we attempt to fill one compartment of a divided vessel to a slightly higher level than that found in the other.

A difference of atmospheric pressure at sea level is thus immediately followed by a movement of the surface air, or by winds; and these differences of pressure have their origin in differences of temperature. If the atmosphere were everywhere of uniform temperature it would lie at rest on the earth's surface—sluggish, torpid, and oppressive—and there would be no winds. This, however, is fortunately not the case. The temperature of the atmosphere is continually or periodically higher in one region than in another, and the chief variations in the distribution of temperature are systematically repeated year after year, giving rise to like systematic variations in the distribution of pressure.

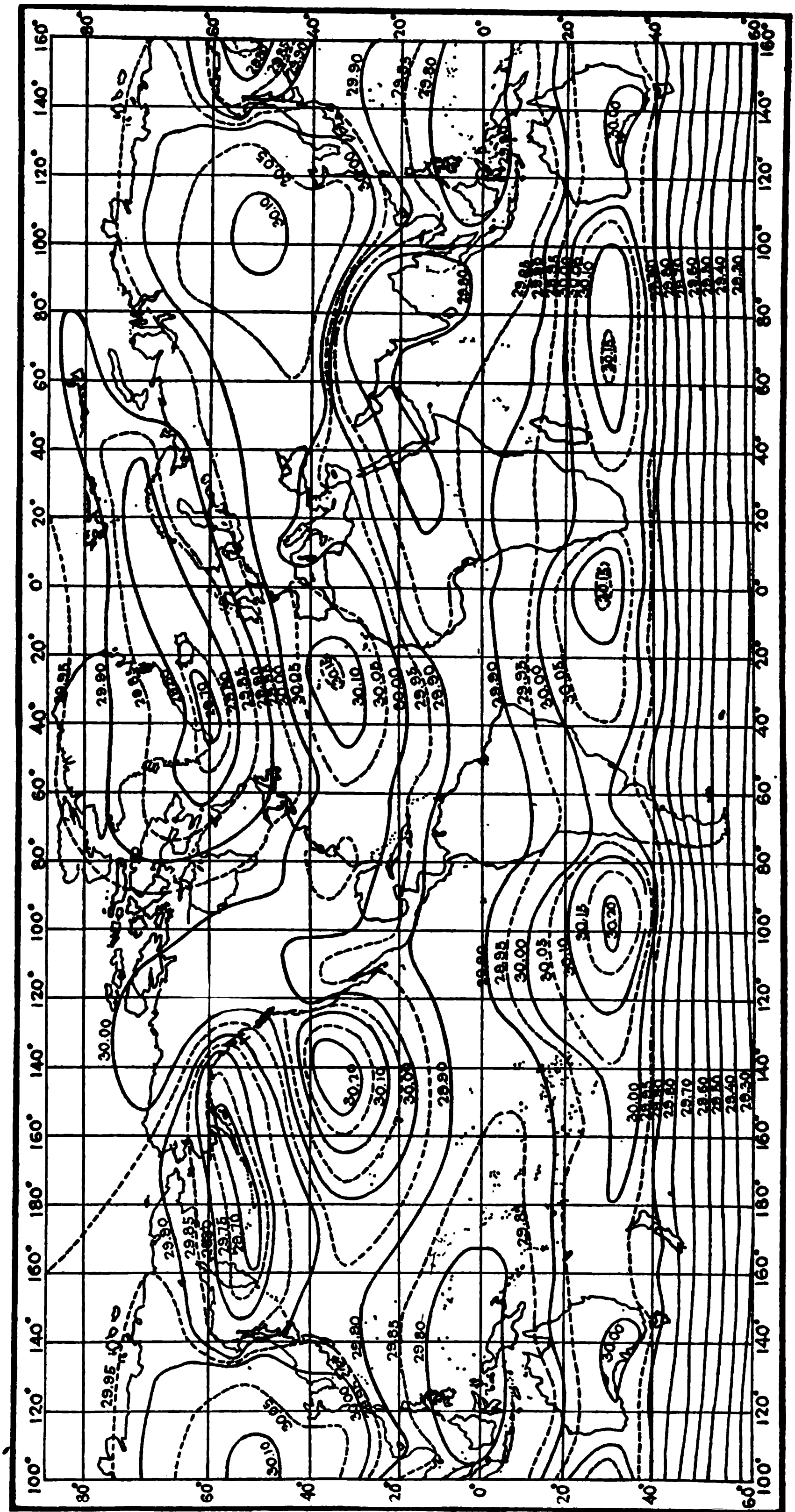
460. The Normal Distribution of Pressure.—The winds, while thus due primarily to differences of temperature, stand in more direct relation to differences of pressure, and it is from this point of view that they are ordinarily studied.

In order to furnish a comprehensive view of this distribution of atmospheric pressure over the earth's surface, charts have been prepared showing the average reading of the barometer for any given period, whether a month, a season, or a year, and covering as far as possible the entire globe. These are known as isobaric charts, from the fact that all points at which the barometer has the same reading are joined by a continuous line or isobar.

The isobaric chart for the year (fig. 69) shows in each hemisphere a well-defined belt of high pressure (30.20 inches) completely encircling the globe, that in the northern hemisphere having its middle line about in latitude 35° North, that in the southern hemisphere about in latitude 30° South, these constituting the so-called meteorological tropics. From the summit or ridge of each of these belts the pressure falls off alike toward the equator and toward the pole, although much less rapidly in the former direction than in the latter. The equator itself is encircled by a belt of somewhat diminished pressure (29.90 inches), the middle line of which is ordinarily found in northern latitudes. In the northern hemisphere the diminution of pressure on the poleward slope is much less marked and much less regular than in the southern hemisphere, minima (29.70 inches) occurring in the North Atlantic Ocean near Iceland and in the North Pacific Ocean near the Aleutian Islands, beyond which the pressure increases. In the southern hemisphere no such minima are apparent, the pressure continuing to diminish uninterruptedly as higher and higher latitudes are attained. Along the sixtieth parallel of south latitude the average barometric reading is 29.30 inches.

461. Seasonal Variations of Pressure.—As might be expected from its close relation to the temperature, the whole system of pressure distribution exhibits a tendency to follow the sun's motion in declination, the barometric equator occupying in July a position slightly to the northward of its position in January. In either hemisphere, moreover, the pressure over the land during the winter season is decidedly above the annual average, during the summer season decidedly below it; the extreme variations occurring in the case of continental Asia, where the mean monthly pressure ranges from 30.50 inches during January to 29.50 inches during July. Over the northern ocean, on the other hand, conditions are reversed, the summer pressures being here somewhat the higher. Thus, in January the Icelandic and the Aleutian minima increase in depth to 29.50 inches, while in July these minima fill up and are well-nigh obliterated, a fact which has much to do with the strength and frequency of the winter gales in high northern latitudes and the absence of these gales during the summer. Over the southern ocean, in keeping with its slight contrast between winter and summer temperatures, similar variations of pressure do not exist.

462. The Prevailing Winds.—As a result of the distribution of pressure just described, there is in either hemisphere a continual motion of the surface air away from the meteorological tropic—on one side toward the equator, on the other side toward the pole, the first constituting in each case the trade winds, the second the prevailing winds of higher latitudes. Upon a stationary earth the direction of this motion would be immediately from the region of high toward the region of low barometer, the moving air steadily following the barometric slope or gradient, increasing in force to a gale where these gradients are steep, decreasing to a light breeze where they are gentle, sinking to a calm where they are absent. The earth, however, is in rapid rotation, and this rotation gives rise to a force which exercises a material influence over all horizontal motions upon its surface, whatever their direction, serving constantly to divert them to the *right* in the northern hemisphere, to the *left* in the southern. The air set in motion by the difference of pressure is thus constantly turned aside from its natural course down the barometric gradient or slope, and the direction of the wind at any point, instead of being identical with that of the gradient at that point, is deflected by a certain amount, crossing the latter at an angle which in practice varies between 45° and 90° (4 to 8 compass points), the wind in the latter case blowing parallel to the isobars. As a consequence of this deflection the northerly winds which one would naturally expect to find on the equatorial slope of the belt of high pressure in the northern hemisphere become


80°
60°
40°
20°
0°
20°
40°
60°
160°
140°
120°
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80°
100°
120°
140°
160°
180°
160°
140°
120°
100°
29.30
29.40
29.50
29.60
29.70
29.75
29.80
29.85
29.90
29.95
30.00
30.05
30.10
30.15
30.20

FIG. 69.

northeasterly—the NE. trade; the southerly winds of the polar slope become southwesterly—the prevailing westerly winds of northern latitudes. So, too, for the southern hemisphere, the southerly winds of the equatorial slope here becoming southeasterly—the SE. trades; the northerly winds of the polar slope northwesterly—the prevailing westerly winds of southern latitudes.

463. The relation here described as existing between the distribution of atmospheric pressure and the direction of the wind is of the greatest importance. It may be briefly stated as follows:

In the northern hemisphere stand with the face to the wind; in this position the region of high barometer lies on your left hand and somewhat in front of you; the region of low barometer on your right hand and somewhat behind you.

In the southern hemisphere stand with the face to the wind; in this position the region of high barometer lies on your right hand and somewhat in front of you; the region of low barometer on your left hand and somewhat behind you.

This relation holds absolutely, not only in the case of the general distribution of pressure and circulation of the atmosphere, but also in the case of the special conditions of high and low pressure which usually accompany severe gales.

464. THE TRADE WINDS.—The *Trade Winds* blow from the tropical belts of high pressure toward the equatorial belt of low pressure—in the northern hemisphere from the northeast, in the southern hemisphere from the southeast. Over the eastern half of each of the great oceans they extend considerably farther from the line and their original direction inclines more toward the pole than in midocean, where the latter is almost easterly. They are ordinarily looked upon as the most constant of winds, but while they may blow for days or even for weeks with slight variation in direction or strength, their uniformity should not be exaggerated. There are times when the trade winds weaken or shift. There are regions where their steady course is deformed, notably among the island groups of the South Pacific, where the trades during January and February are practically nonexistent. They attain their highest development in the South Atlantic and in the South Indian Ocean, and are everywhere fresher during the winter than during the summer season. They are rarely disturbed by cyclonic storms, the occurrence of the latter within the limits of the trade-wind region being furthermore confined in point of time to the late summer and autumn months of the respective hemispheres, and in scene of action to the western portion of the several oceans. The South Atlantic Ocean alone, however, enjoys complete immunity from tropical cyclonic storms.

465. THE DOLDRUMS.—The equatorial girdle of low pressure occupies a position between the high-pressure belt of the northern and the similar belt of the southern hemisphere. Throughout the extent of this barometric trough the pressure, save for the slight diurnal oscillation, is practically uniform, and decided barometric gradients do not exist. Here, accordingly, the winds sink to stagnation, or rise at most only to the strength of fitful breezes, coming first from one point of the compass, then from another, with cloudy, rainy sky and frequent thunderstorms. The region throughout which these conditions prevail consists of a wedge-shaped area, the base of the wedge resting in the case of the Atlantic Ocean on the coast of Africa, and in the case of the Pacific Ocean on the coast of America, the axis extending westward. The position and extent of the belt vary somewhat with the season. Throughout February and March it is found immediately north of the equator and is of inappreciable width, vessels following the usual sailing routes frequently passing from trade to trade without interruption in both the Atlantic and the Pacific Oceans. In July and August it has migrated to the northward, the axis extending east and west along the parallel of 7° north, and the belt itself covering several degrees of latitude, even at its narrowest point. At this season of the year, also, the southeast trades blow with diminished freshness across the equator and well into the northern hemisphere, being here diverted, however, by the effect of the earth's rotation, into southerly and southwesterly winds, the so-called southwest monsoon of the African and Central American coasts.

466. THE HORSE LATITUDES.—On the outer margin of the trades, corresponding vaguely with the summit of the tropical ridge of high pressure in either hemisphere, is a second region throughout which the barometric gradients are faint and undecided, and the prevailing winds correspondingly light and variable, the so-called *horse latitudes*, or calms of Cancer and of Capricorn. Unlike the doldrums, however, the weather is here clear and fresh, and the periods of stagnation are intermittent rather than continuous, showing none of the persistency which is so characteristic of the equatorial region. The explanation of this difference will become obvious as soon as we come to study the nature of the daily barometric changes of pressure in the respective regions, these in the one case being marked by the uniformity of the torrid zone, in the other sharing to a limited extent in the wide and rapid variations of the temperate.

467. The Prevailing Westerly Winds.—On the exterior or polar side of the tropical maxima the pressure again diminishes, the barometric gradients being now directed toward the pole; and the currents of air set in motion along these gradients, diverted to the right and left of their natural course by the earth's rotation, appear in the northern hemisphere as southwesterly winds, in the southern hemisphere as northwesterly—the prevailing westerly winds of the temperate zone.

Only in the southern hemisphere do these winds exhibit anything approaching the persistency of the trades, their course in the northern hemisphere being subject to frequent local interruption by periods of winds from the eastern semicircle. Thus the tabulated results show that throughout the portion of the North Atlantic included between the parallels 40°–50° North, and the meridians 10°–50° West, the winds from the western semicircle (South—NNW.) comprise about 74 per cent of the whole number of observations, the relative frequency being somewhat higher in winter, somewhat lower in summer. The average force, on the other hand, decreases from force 6 to force 4 Beaufort scale, with the change of season. Over the sea in the southern hemisphere such variations are not apparent; here the westerlies blow through the entire year with a steadiness little less than that of the trades themselves, and with a force which, though fitful, is very much greater, their boisterous nature giving the name of the "Roaring Forties" to the latitudes in which they are most frequently observed.

The explanation of this striking difference in the extra-tropical winds of the two halves of the globe is found in the distribution of atmospheric pressure, and in the variations which this latter undergoes in different parts of the world. In the landless southern hemisphere the atmospheric pressure after crossing the parallel of 30° South diminishes almost uniformly toward the pole, and is rarely disturbed by those large and irregular fluctuations which form so important a factor in the daily weather of the northern hemisphere. Here, accordingly, a system of polar gradients exists quite comparable in stability with the equatorial gradients which give rise to the trades; and the poleward movement of the air in obedience to these gradients, constantly diverted to the left by the effect of the earth's rotation, constitutes the steady westerly winds of the south temperate zone.

468. The Monsoon Winds.—The air over the land is warmer in summer and colder in winter than that over the adjacent oceans. During the former season the continents thus become the seat of areas of relatively low pressure; during the latter of relatively high. Pressure gradients, directed outward during the winter, inward during the summer, are thus established between the land and the sea, which exercise the greatest influence over the winds prevailing in the region adjacent to the coast. Thus, off the Atlantic seaboard of the United States southwesterly winds are most frequent in summer, northwesterly winds in winter; while on the Pacific coast the reverse is true, the wind here changing from northwest to southwest with the advance of the colder season.

The most striking illustration of winds of this class is presented by the *monsoons* (*Mausum*, season) of the China Sea and of the Indian Ocean. In January abnormally low temperatures and high pressure obtain over the Asiatic plateau, high temperatures and low pressure over Australia and the nearby portion of the Indian Ocean. As a result of the baric gradients thus established, the southern and eastern coast of the vast Asiatic continent and the seas adjacent thereto are swept by an outflowing current of air, which, diverted to the right of the gradient by the earth's rotation, appears as a northeast wind, covering the China Sea and the northern Indian Ocean. Upon entering the southern hemisphere, however, the same force which hitherto deflected the moving air to the right of the gradient now serves to deflect it to the left; and here, accordingly, we have the monsoon appearing as a northwest wind, covering the Indian Ocean as far south as 10°, the Arafura Sea, and the northern coast of Australia.

In July these conditions are precisely reversed. Asia is now the seat of high temperature and correspondingly low pressure, Australia of low temperature and high pressure, although the departure from the annual average is by no means so pronounced in the case of the latter as in that of the former. The baric gradients thus lead across the equator and are addressed toward the interior of the greater continent, giving rise to a system of winds whose direction is southeast in the southern hemisphere, southwest in the northern.

The northeast (winter) monsoon blows in the China Sea from October to April, the southwest (summer) monsoon from May to September. The former is marked by all the steadiness of the trades, often attaining the force of a moderate gale; the latter appears as a light breeze, unsteady in direction, and often sinking to a calm. Its prevalence is frequently interrupted by tropical cyclonic storms, locally known as *typhoons*, although the occurrence of these latter may extend well into the season of the winter monsoon.

469. LAND AND SEA BREEZES.—Corresponding with the seasonal contrast of temperature and pressure over land and water, there is likewise a diurnal contrast which exercises a similar though more local effect. In summer particularly, the land over its whole area is warmer than the sea by day, colder than the sea by night, the variations of pressure thus established, although insignificant, sufficing to evoke a system of littoral breezes directed landward during the daytime, seaward during the night, which, in general, do not penetrate to a distance greater than 30 miles on and off shore, and extend but a few hundred feet into the depths of the atmosphere.

The sea breeze begins in the morning hours—from 9 to 11 o'clock—as the land warms. In the late afternoon it dies away. In the evening the land breeze springs up, and blows gently out to sea until morning. In the tropics this process is repeated day after day with great regularity. In our own latitudes, the land and sea breezes are often masked by winds of cyclonic origin.

470. A single important effect of the seasonal variation of temperature and pressure over the land remains to be described. If there were no land areas to break the even water surface of the globe, the trades and westerlies of the terrestrial circulation would be developed in the fullest simplicity, with linear divisions along latitude circles between the several members—a condition nearly approached in the land-barren southern hemisphere during the entire year, and in the northern hemisphere during the winter season. In the summer season, however, the tropical belt of high pressure is broken where it crosses the warm land, and the air shouldered off from the continents accumulates over the adjacent oceans, particularly in the northern or land hemisphere. This tends to create over each of the oceans a circular or elliptical area of high pressure, from the center of which the baric gradients radiate in all directions, giving rise to an outflowing system of winds, which by the effect of the earth's rotation is converted into an outflowing spiral eddy or *anticyclonic whirl*. The sharp lines of demarcation which would otherwise exist between the several members of the general circulation are thus obliterated, the southwesterly winds of the middle northern latitudes becoming successively northwesterly, northerly, and northeasterly, as we approach the equator and round the area of high pressure by the east; the northeast trade becoming successively southeasterly, southerly, and southwesterly, as we recede from the equator and round this area by the west; similarly for the other hemisphere.

CHAPTER XIX.

CYCLONIC STORMS.

471. Variations of the Atmospheric Pressure.—The distribution of the atmospheric pressure previously described (Chap. XVIII) and the attendant circulation of the winds are those which become evident after the effects of many disturbing causes have been eliminated by the process of averaging, or embracing in the summation observations covering an extended period of time. The distribution of pressure and the system of winds which actually exist at a given instant will in general agree with these in its main features, but may differ from them materially in detail.

Confining our attention for the time being to the subject of atmospheric pressure, it may be said that this, at any given point on the earth's surface, is in a constant state of change, the mercurial barometer rarely becoming stationary, and then only for a few hours in succession. The variations which the pressure undergoes may be divided into two classes, viz, periodic, or those which are continuously in operation, repeating themselves within fixed intervals of time, long or short; and nonperiodic or accidental, which occur irregularly, and are of varying duration and extent.

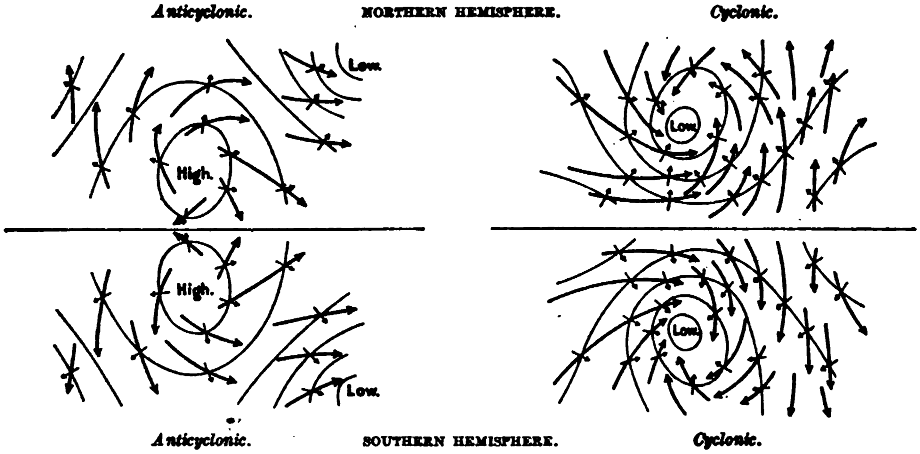
472. Periodic Variations.—Of the former class of changes the most important are the seasonal, which have been already to some extent described, and the diurnal. The latter consists of the daily occurrence of two barometric maxima, or points of highest pressure, with two intervening minima. Under ordinary circumstances with the atmosphere free from disturbances, the barometer each day attains its first minimum about 4 a. m. As the day advances the pressure increases, and a maximum, or point of greatest pressure, is reached about 10 a. m. From this time the pressure diminishes, and a second minimum is reached about 4 p. m., after which the mercury again rises, reaching its second maximum about 10 p. m. The range of this diurnal oscillation is greatest at the equator, where it amounts to ten hundredths (0.10) of an inch. It diminishes with increased latitude, and near the poles it seems to vanish entirely. In middle latitudes it is much more apparent in summer than in winter.

473. Nonperiodic Variations.—The equatorial slope of the tropical belt of high pressure which encircles the globe in either hemisphere is characterized by the marked uniformity of its meteorological conditions, the temperature, wind, and weather changes proper to any given season repeating themselves as day succeeds day with almost monotonous regularity. Here the diurnal oscillation of the barometer constitutes the main variation to which the atmospheric pressure is subjected. On the polar slope of these belts conditions the reverse of these obtain, the elements which go to make up the daily weather here passing from phase to phase without regularity, with the result that no two days are precisely alike; and as regards atmospheric pressure, it may be said that in marked contrast with the uniformity of the torrid zone, the barometer in the temperate zone is constantly subjected to nonperiodic or accidental fluctuations of such extent that the periodic diurnal variation is scarcely apparent, the mercurial barometer at a given station frequently rising or falling several tenths of an inch in twenty-four hours.

474. Progressive Areas of High and Low Pressure.—The explanation of this rapid change of conditions is found in the approach and passage of extensive areas of alternately high and low pressure, which affect alike, although to a different degree, all the barometers coming within their scope. The general direction of motion of these areas is that of the prevailing winds; eastward, therefore, in the latitudes which are under consideration.

Taken in conjunction, these areas of high and low pressure exercise a controlling influence over the weather changes of the temperate zones. As the low area draws near, the sky becomes overclouded, the prevailing westerly wind falls away, and is succeeded by a wind from some easterly direction, faint at first, but increasing as the pressure continues to diminish; the lowest pressure having been reached, the wind again goes to the westward, the barometer starts to rise, and the weather clears; all marking the eastward recession of the low area and the approach of the subsequent high.

The first stage in the development of the low is a slight diminution of the atmospheric pressure, amounting in general to not more than one or two hundredths of an inch, throughout an area covering a more or less extensive portion of the earth's surface, either land or water, but far more frequently over the former than over the latter. Shortly after the advent of this initiatory fall the decrease of pressure throughout some small region within the larger area assumes a more decided character, the mercury here standing at a lower level than elsewhere and reading successively higher as we go outward, the region thus becoming, as it were, the center of the whole barometric depression. A system of barometric gradients is by this means established, all directed radially inward, and in obedience to these gradients there is a movement of the surface air toward the center or point of lowest barometer. The air once in motion, however, the effect of the earth's rotation is brought into play precisely as in the case of the larger movements of the atmosphere, with the result that the several currents, instead of following the natural course along these gradients, are deflected from them, in the northern hemisphere to the right hand, in the southern hemisphere to the left, the extent of the deflection being from 4 to 8 compass points.


Anticyclonic. NORTHERN HEMISPHERE. *Cyclonic.*

Anticyclonic. SOUTHERN HEMISPHERE. *Cyclonic.*

FIG. 70.

The light arrows show the direction of the gradients; the heavy arrows the direction of the winds.

475. CYCLONES AND CYCLONIC CIRCULATIONS.—A central area of low barometer will thus be surrounded by a system of winds which constantly draw in toward the center but at the same time circulate about it, the whole forming an inflowing spiral; the direction of this circulation being in the southern hemisphere with the motion of the hands of a watch, in the northern hemisphere opposed to this motion. Where the barometric gradients are steep, these winds are apt to be strong; where they are gentle, the winds are apt to be weak; where they are absent, as is the case at the center or bottom of the depression, calms are apt to prevail.

Around the center of the area of high pressure a similar system of wind will be found, but blowing in a contrary direction. Here the barometric gradients are directed radially outward, with the result that in place of the inflowing, we have an outflowing spiral, the circulatory motion being right handed or with the hands of a watch in the northern hemisphere, left handed or against the hands of a watch in the southern.

All these features are shown in the accompanying diagrams (fig. 70), which exhibit the general character of cyclonic (around the low) and anticyclonic (around the high) circulations in the northern and the southern hemisphere, respectively.

The closed curves represent the isobars, or lines along which the barometric pressure is the same; the short arrows show the direction of the gradients, which are everywhere at right angles to the isobars; the long arrows give the direction of the winds, deflected by the earth's rotation to the right of the gradients in the northern hemisphere, to the left in the southern.

476. FEATURES OF CYCLONIC AND ANTICYCLONIC REGIONS.—Certain features of the two areas may here be contrasted. In the anticyclonic, the successive isobars are as a rule far apart, showing weak gradients and consequently light winds; the areas themselves are of relatively great extent, and their rate of progression is slow. During the summer they originate as extensions into higher latitudes of the margins of the tropical belts of high pressure; during the winter, as offshoots of the strong anticyclone which covers the land throughout that season. Their approach and presence is accompanied by polar or westerly winds, temperature below the seasonal average, fair weather, and clear skies. In the cyclonic area the successive isobars are crowded together, showing steep gradients and strong winds; they may appear either as trough-like extensions into the temperate zone of the polar belt of low pressure, in which case the easterly winds proper to their polar side are nonexistent, or (in lower latitudes) as independent areas, sometimes, indeed, as detached portions of the equatorial low-pressure belt, which move eastward and poleward across the temperate zone, and are ultimately merged into the great cyclonic area surrounding the pole. The progress of these independent areas is invariably attended by the strong and steadily shifting winds, foul weather, and other features which make up the ordinary storm at sea. In the trough-like depressions of higher latitudes these features may or may not be observed, their presence depending upon the depths of the barometric trough and the steepness of its slopes. In these, moreover, the cyclonic circulation is never completely developed, the storm winds having rather the character of right line gales, blowing from an equatorial or easterly direction until the axis of the trough is at hand, and as this passes shifting by the west at one bound to a polar direction.

477. CYCLONIC STORMS.—Strong winds are the result of steep barometric gradients. These may occur with cyclonic or with anticyclonic areas, the latter being exemplified in the case of the northers in the Gulf of Mexico and the northwesterly winter gales along the Atlantic coast of the United States, which are almost invariably accompanied by barometers above the average. They are, however, so much more frequent in the case of areas of low pressure and consequent cyclonic circulations, with their attendant foul-weather characteristics, that the latter are generally known as cyclonic storms, i. e., storms in which the wind circulation is cyclonic.

Cyclonic storms may with convenience be divided into two classes: viz, tropical, or those which originate near but not on the equator; and extra-tropical, or those which first appear in higher latitudes.

478. TROPICAL CYCLONIC STORMS.—The occurrence of tropical cyclonic storms is confined to the summer and autumn months of the respective hemispheres, and to the western part of the several oceans, the North Atlantic, the North Pacific, the South Pacific, and the Indian Ocean. They are unknown in the South Atlantic Ocean. Although these cyclonic storms are all of the same essential characteristics, they have generally been called hurricanes when occurring in the West Indies and the region between Samoa and Australia, typhoons when occurring in the region of the Philippines, and cyclones when occurring in the Indian Ocean and its dependent seas.

The limits of the regions within which these tropical storms originate are defined by parallels of latitude and meridians of longitude as follows:

	Latitude.	Longitude from Greenwich.
Hurricanes of the West Indies	12° to 28° N.	55° to 95° W.
Typhoons of the Philippine region	5 to 20 N.	150 to 115 E.
Cyclones of the Bay of Bengal	8 to 22 N.	100 to 80 E.
Cyclones of the Indian Ocean	4 to 30 S.	100 to 40 E.
Hurricanes of the Samoan region	10 to 30 S.	160 W. to 150 E.

The percentage of frequency of these storms in the different months of the year is set forth in the following table:

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Hurricanes of the West Indies	0	0	0	0	1	6	4	25	32	31	1	0
Typhoons of the Philippine region	2	0.4	1	2	5	9	16	16	19	14	11	5
Cyclones of the Bay of Bengal	0	0	0	0	6	12	19	15	20	14	10	4
Cyclones of the Indian Ocean	22	19	18	15	6	1	0.5	0	0	1.5	7	10
Hurricanes of the Samoan region	29	17.5	28	6	1	0	0	0	1.5	1	3	13

The yearly average number of those occurring in the West Indian region is 4, in the Philippine region 21, in the Bay of Bengal 9, in the Indian Ocean (south of the Equator) 9, and in the region between Samoa and Australia 4.

479. Motion of the Storm Center.—In the case of tropical cyclonic storms there is always a tendency for the barometric depression, impelled by the general motion of the atmosphere in the trade-wind region, to follow a path which tends at once westward and away from the equator. This motion continues until the limits of the trades are reached, where the path ordinarily recurves; and the subsequent motion of the depression is eastward and toward the pole, the disturbance at the same time assuming the features of the extra-tropical cyclonic storm.

Rate of progress of the storm center.—Within the tropics in the northern hemisphere, the average velocity of the storm center along the path is 11 miles an hour; and in the latitude of the recurvature of the storm this average is maintained, although there are numerous instances of wide variations in the rate of progress here, and sometimes the center becomes stationary for a few days. In higher latitudes, the rate increases to an average of 16 miles an hour.

In the southern hemisphere, the average velocity of progress as far as determined is somewhat less than in the northern; and, in the Indian Ocean, many of the Mauritius cyclones have a very small movement of translation, and these are, in consequence, designated as stationary cyclones.

The general path of the tropical cyclonic storm in either hemisphere and the cyclonic circulation of the wind about the storm center are given in figures 73 and 74; that for the northern hemisphere applying to the hurricanes of the West Indies; that for the southern hemisphere to the hurricanes of the South Pacific Ocean.

480. Indications of the Approach of Tropical Cyclonic Storms.—The premonitory signs of a tropical cyclonic storm comprise, besides those feelings of personal discomfort which are common within the sphere of atmospheric disturbance of cyclonic storms in all parts of the world, (1) an unsteady barometer, or even a cessation of the diurnal range, which is constant in settled weather; (2) a heavy swell not caused by the wind then blowing; (3) the appearance of the sky arising from the forms and movements of the clouds. It is upon the concomitance of these indications, rather than the recognition of any one of them, that reliance should be placed.

The appearance of the clouds and their value as storm warnings is described as follows by Faura in the Cyclones of the Far East, by José Algue, of the Manila Observatory:

> The best means for determining the center [of a storm] and for following up its movements are the observations of cirri, little clouds of a very fine structure and clear opal color, which appear as elongated feathers. * * * Long before the least sign of bad weather is noticeable and in many cases when the barometer is still very high—being under the influence of a center of high pressure, which generally precedes a tempest—these small isolated clouds appear in the upper regions of the atmosphere. They seem to be piled up on the blue vault of heaven and drawn out in the direction of some point on the horizon toward which they converge. The first to present themselves are few in number but well defined and of the most delicate structure, appearing like filaments bound together but whose visibility is lost before they reach the point of radiation. We often had an opportunity to watch them at the observatory of Manila, when the center was still 600 miles distant. The best times for observing the cirri are sunrise and sunset. If the sun is in the east and very near the horizon, the first clouds which are tinged by the solar rays are the cirro-strati which precede the cyclone, and they are also the last to disappear at sunset, inasmuch as they overspread the horizon. Such times are the best for determining the radiant point of the cloud streaks and at the same time for ascertaining the direction in which the center lies. Later on the delicacy of form, which characterizes this class of clouds in its earlier stages, is lost, and the clouds

appear in more confused and tangled forms, like streamers of feather work, with central nuclei, which still maintain this direction, so that the point of radiation can still be detected. In order to ascertain approximately the direction in which the center is advancing in its movement of translation, it is necessary to determine the changes of the radiant point at equal intervals of time and to compare them with the movements of the barometer. If the point of convergence does not perceptibly change its position, but remains fixed and immovable for a long time, even for several consecutive days, it is almost certain that

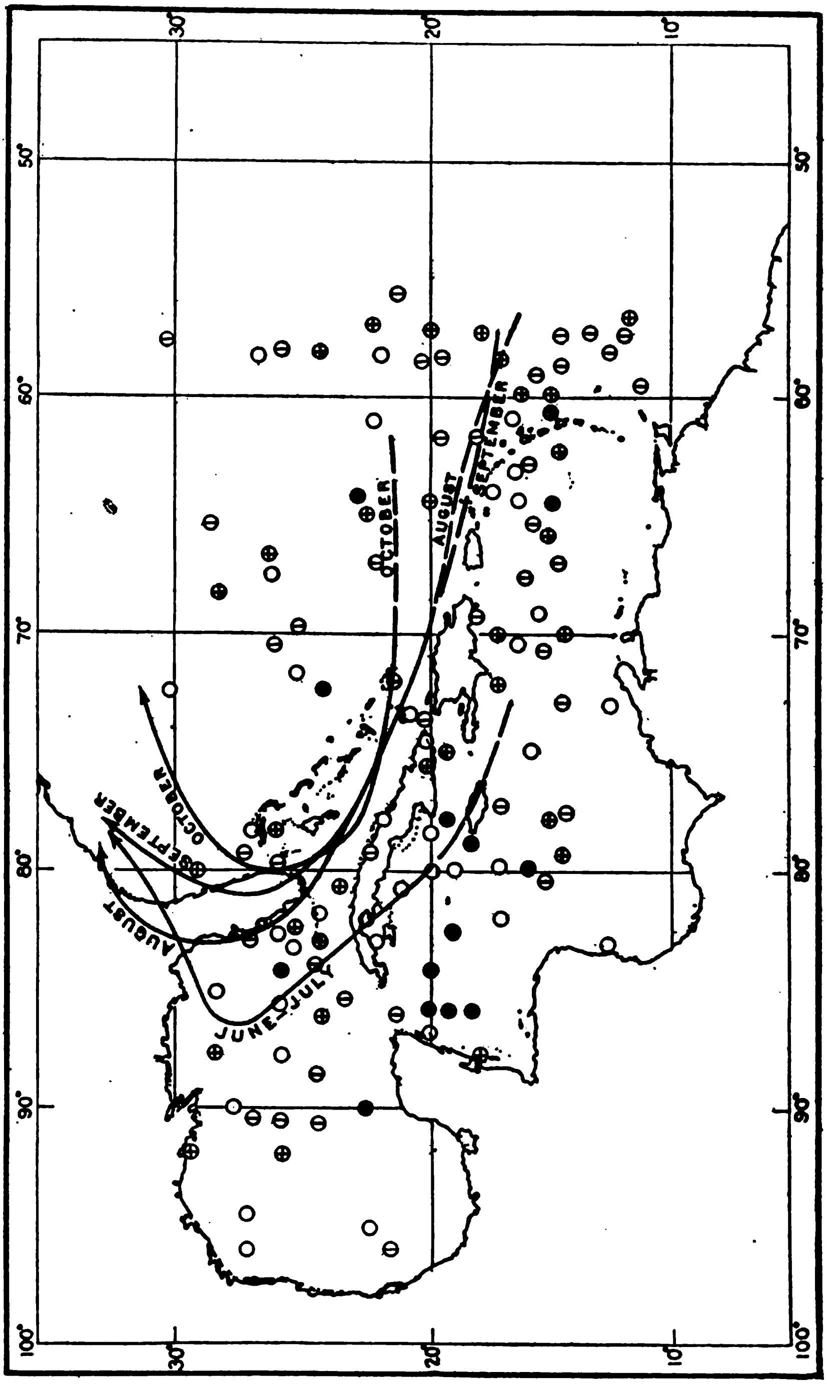


FIG. 71.—Average Paths of Hurricanes in the West Indies.

The small circles indicate the points of origin of 130 storms, which comprise all the instances resulting from the authentic accounts of a period of 35 years.

● June and July storms
⊕ August storms
⊖ September storms
○ October storms

the tempest will break over the position of the observer. In this case the barometer begins to fall shortly after the first cirrus clouds have been observed and sometimes even before. At first it falls slowly, without

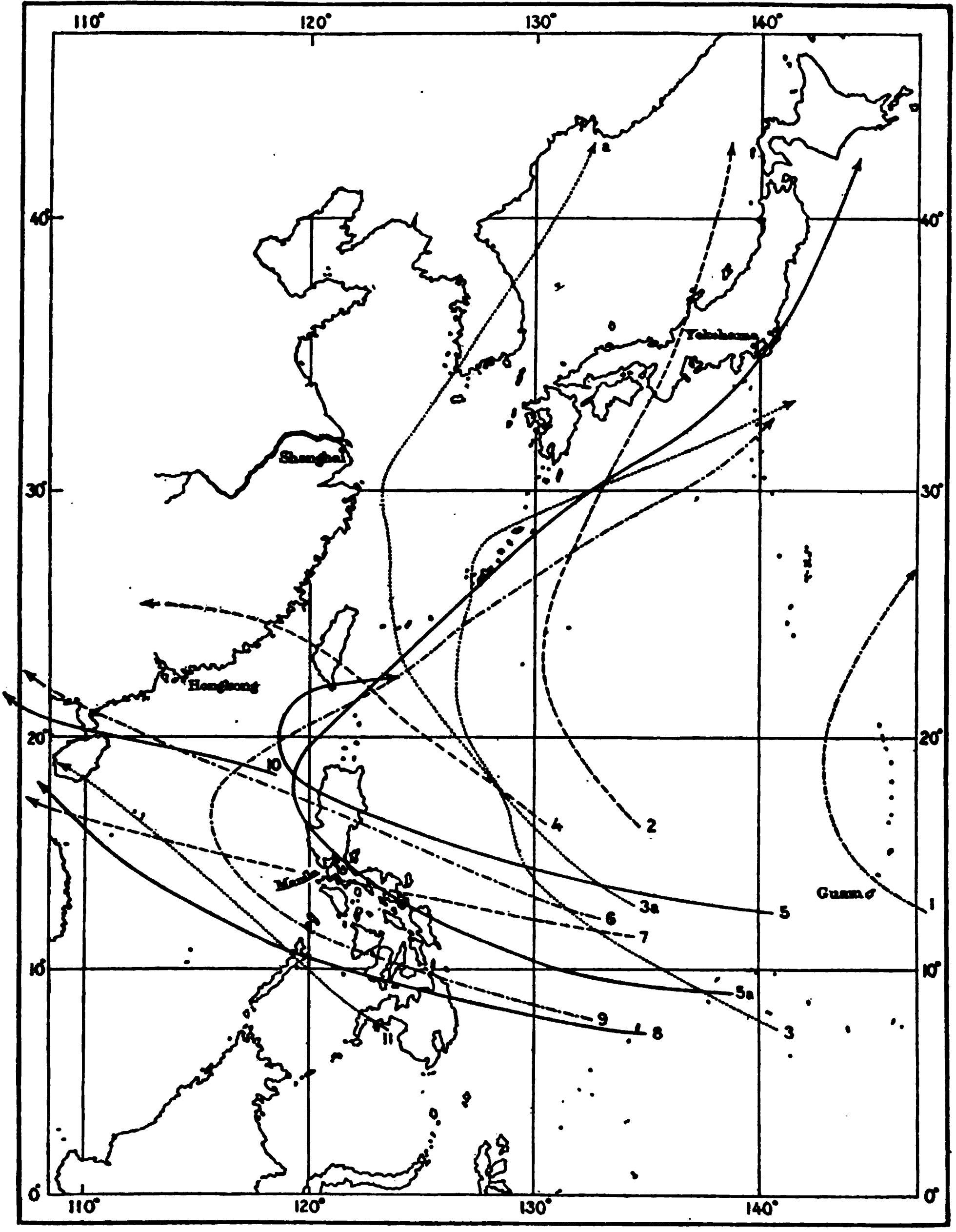


FIG. 72.—Mean Paths of Typhoons.

1. Typhoons in the Marianas.
2. Typhoons formed in the Pacific which, at some distance east of the meridian of Manila, have recurved toward Japan.
3 and 3a. Typhoons formed in the Pacific which, near the meridian of Manila, have recurved toward Japan.
4. Typhoons of Taiwan or Formosa.
5 and 5a. Typhoons of northern Luzon which have recurved in the island or near it in the China Sea.
6. Typhoons which have crossed Luzon northward of Manila and continued to the continent.
7. Typhoons which have crossed Luzon southward of Manila.
8. Typhoons of the Visayas and Mindanao.
9. Typhoons formed in the Pacific which have crossed south of Manila, recurved in the China Sea between latitudes 10 degrees and 20 degrees, and recrossed north of Manila.
10. Typhoons formed in the China Sea.
11. Typhoons formed in the Sulu Sea and the interisland waters.

completely losing the diurnal and nocturnal oscillatory movements, but changing somewhat the hours of maximum and minimum. The daily reading is observed to be each day less than that of the preceding day. That part of the horizon in the direction of the storm begins to be covered by a cirrus veil, which increases slowly until it forms an almost homogeneous covering of the sky. This veil is known by the name "cirro-pallium" of Poëy, and is that which causes the solar and lunar halos, which are never absent when a storm approaches. Beneath the veil a few isolated clouds, commonly called "cotton," appear. They are much more numerous and larger on the side lying toward the storm, where they soon appear as a compact mass. At such times the sunrises and sunsets are characterized by the high red tint which the clouds assume, resembling a great fire, especially in the direction of the cyclone. The wind remains fixed at one point, showing only a few variations, which are due principally to the squalls, which continually exert their force within the limits of the storm. The low or "cotton" clouds successively and from time to time cover the sky, throwing out occasional squalls of rain and wind; but, the squalls having passed, a lull ensues, the cirrus veil remaining, and likewise the hurricane bank of clouds, which seems fixed to the same spot in the direction of the storm. This state of the atmosphere continues until the bank of clouds invades the point of observation, in which case the squalls will be continuous and the wind will increase in violence each moment.

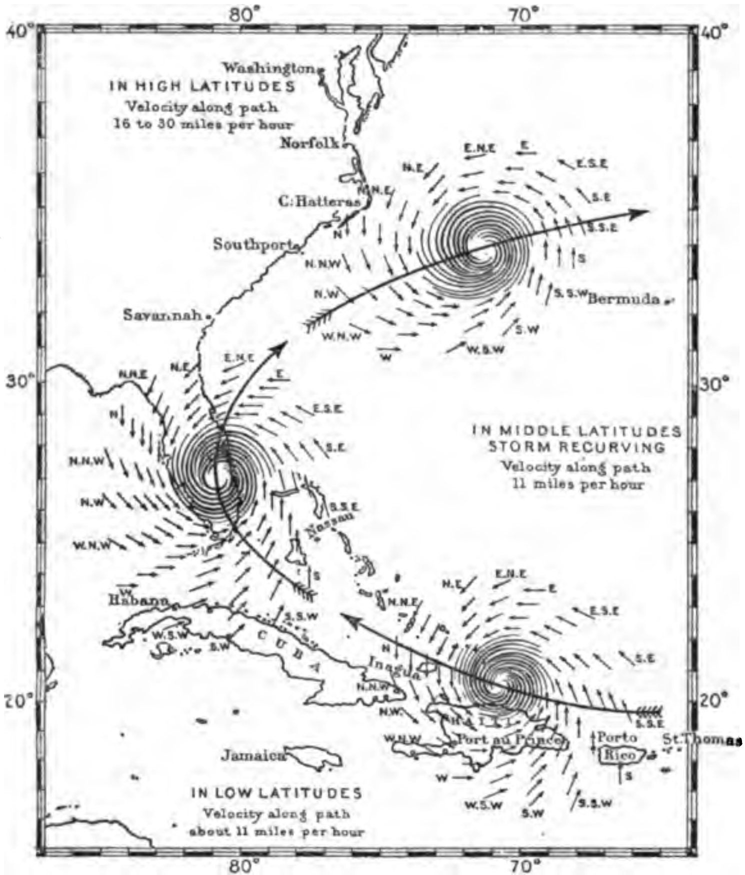


Fig. 73.

The condition of diminished pressure attending a cyclonic storm gives rise to high waves which are propagated in all directions from such a storm on the ocean. These waves outrun the storm as much as a thousand miles, and, by the direction from which they arrive, indicate the bearing of the storm's center.

Although thunderstorms can not be considered as premonitory signs, it rarely happens that showers and squalls are not experienced from 24 to 48 hours in advance of the storm; and the unsettled state of the barometer in the distant approaches, varying from 500 to 1,000 miles in advance of the center, gives place, at a distance of 300 to 400 miles, to a slow and steady fall of the mercurial column. At the same time the direction and velocity of the lower clouds show unmistakable evidence of the presence of a storm and the bearing of the center. When the storm center is still far distant, the phenomenon called the "bar of the cyclone" may frequently be seen. This is a dense mass of rain cloud formed about the center of the storm, giving the appearance of a huge bank of black clouds resting upon the horizon, which may retain its form unchanged for hours. It is usually most conspicuous about sunrise or sunset. When it is possible to observe this bar, the changes in its position at intervals of a few hours will enable the observer to determine the direction of movement of the storm.

481. Character of Tropical Cyclonic Storms.—Within the tropics the storm area is small, the region covered by violent winds extending in general not more than 150 miles from the center. The barometric gradients are, however, exceedingly steep, instances having been recorded in which the difference of pressure for this distance amounted to 2 inches. In the typhoons of the North Pacific Ocean gradients of one inch in 60 miles are not infrequent. The successive isobars are almost circular. As a consequence of this distribution of pressure the winds on the slopes of the depression are frequently of great violence, and in the matter of direction they are more symmetrically disposed about the center than is the case with the larger and less regularly shaped depressions of higher latitudes. In these low latitudes the average values of the deflection of the wind from the barometric gradient is in the neighborhood of six compass points—to the right in the northern hemisphere, to the left in the southern.

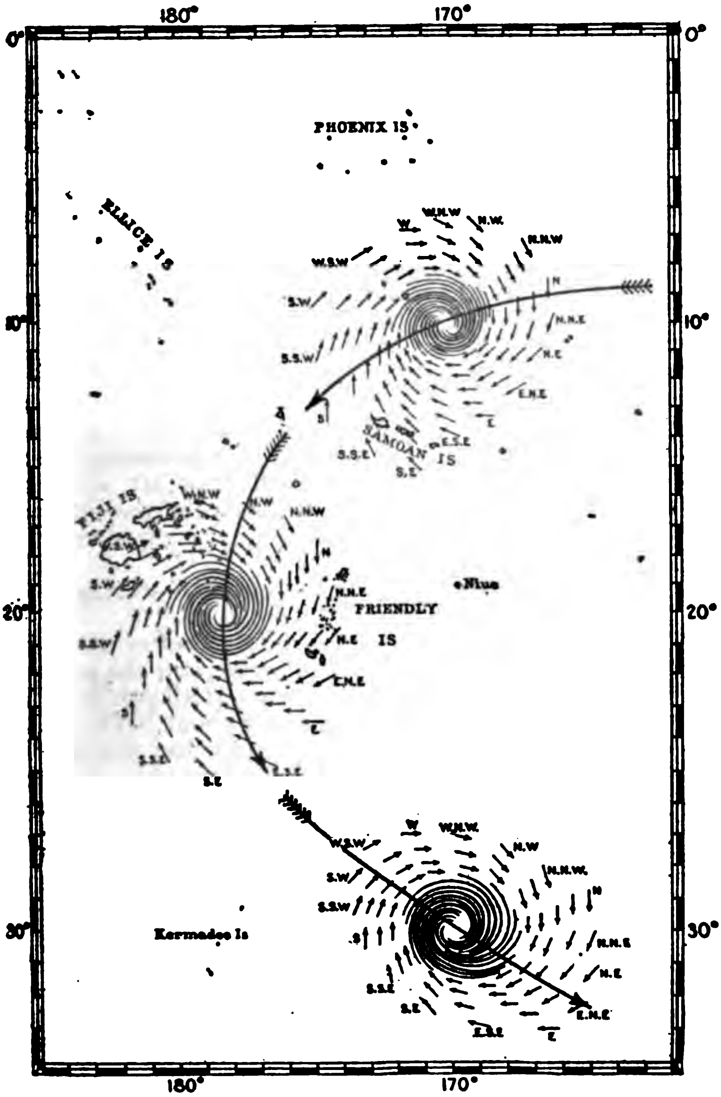


Fig. 74.

482. To Fix the Bearing of the Storm Center from the Vessel.—On this assumption, the following rules will enable an observer to fix the bearing of the storm center from his vessel:

In the northern hemisphere, stand with the face to the wind; the storm center will bear ten points to the observer's right.

In the southern hemisphere, stand with the face to the wind; the storm center will bear ten points to the observer's left.

On the basis of these rules the tables hereafter given (art. 487) show the bearing of the center corresponding to a wind of any direction.

483. To Fix the Distance of the Storm Center from the Vessel.—The following table, taken from Piddington's "Sailor's Horn Book," may prove of some assistance in estimating the distance of the storm center from the vessel:

Average fall of the barometer per hour.	*Distance from the storm center.*
From 0. 02 to 0. 06 in.	From 250 to 150 miles.
From 0. 06 to 0. 08 in.	From 150 to 100 miles.
From 0. 08 to 0. 12 in.	From 100 to 80 miles.
From 0. 12 to 0. 15 in.	From 80 to 50 miles.

The table assumes that the vessel is hove-to in front of the storm and that the latter is advancing directly toward it.

Inasmuch as cyclones are of varying area and of different intensities, the lines of equal barometric pressure (isobars) lie much closer together in some storms than in others, so that, in the circumstances of an observer on the ocean, the estimation of the distance of the center by the height of the mercurial column or of its rate of fall must be somewhat conjectural.

484. To Avoid the Center of the Storm.—In the immediate neighborhood of the center itself the winds attain full hurricane force, the sea is exceedingly turbulent, and there is danger of being taken aback. Every effort should therefore be made to avoid this region, either by running or by heaving-to; and if recourse is had to the latter maneuver, much depends upon the selection of the proper tack; this being in every case the tack which will cause the wind to draw aft with each successive shift.

A vessel hove-to in advance of a tropical cyclonic storm will experience a long heavy swell, a falling barometer with torrents of rain, and winds of steadily increasing force. The shifts of wind will depend upon the position of the vessel with respect to the path followed by the storm center. Immediately upon the path, the wind will hold steady in direction until the passage of the central calm, the "eye of the storm," after which the gale will renew itself, but from a direction opposite to that which it previously had. To the right of the path, or in the right-hand semicircle of the storm (the observer being supposed to face along the track), the wind, as the center advances and passes the vessel, will constantly shift to the right, the rate at which the successive shifts follow each other increasing with the proximity to the center; in this semicircle, then, in order that the wind shall draw aft with each shift, the vessel must be hove-to on the starboard tack; similarly, in the left-hand semicircle, the wind will constantly shift to the left, and here the vessel must be hove-to on the port tack.

These rules hold alike for both hemispheres and for cyclonic storms in all latitudes.

Figure 75 represents a cyclonic storm in the northern hemisphere after recurving. For simplicity the area of low barometer is made perfectly circular, and the center is assumed to be ten points to the right of the direction of the wind at all points within the disturbed area. Let us assume that the center is advancing about NNE., in the direction of the long arrow, shown in heavy full line. The ship *a* has the wind at ENE.; she is to the left of the track, or technically in the navigable semicircle. The ship *b* has the wind at ESE. and is in the dangerous semicircle. As the storm advances these ships, if lying to, *a* upon the port tack, *b* upon the starboard tack, as shown, take with regard to the storm center the successive positions a, a_1, etc., b, b_1, etc., the wind of ship *a* shifting to the left, of ship *b* to the right, or in both cases drawing aft, and thus diminishing the probability of either ship being taken aback, a danger to which a vessel lying to on the opposite tack (i. e., the starboard tack in the left-hand semicircle or the port tack in the right-hand semicircle) is constantly exposed, the wind in the latter case tending constantly to draw forward. The ship *b* is continually beaten by wind and sea toward the storm track. The ship *a* is drifted away from the track, and, should she be able to carry sail, would soon find better weather by running off to the westward.

It must not be forgotten that the shifts of wind will only occur in the above order when the vessel is stationary. When the course and speed are such as to maintain a constant relative bearing between the ship and storm center, there will be no shift of wind. Should the vessel be outrunning the storm, the wind will indeed shift in the opposite direction to that given, and a navigator in the right semicircle, for instance, and judging only by the shifts of wind without taking into account his own run, might imagine himself on the opposite side. In such a case the barometer must be the guide.

An examination of figure 75 shows how this is. A vessel hove to at the position marked *b*, and being passed by the storm center, will occupy successive positions in regard to the center from *b* to b_4, and will experience shifts of wind, as shown by the arrows, from East through South to SW. On the other hand, if the storm center be stationary or moving slowly and a vessel be overtaking it along the line from b_4 to *b*, the wind will back from SW. to East, and is likely to convey an entirely wrong impression as to the location and movement of the center.

485. Dangerous and Navigable Semicircles.—Prior to recurving, the winds in that semicircle of the storm which is more remote from the equator (the right-hand semicircle in the northern hemisphere, the left-hand semicircle in the southern) are liable to be more severe than those of the opposite semicircle. A vessel hove to in the semicircle adjacent to the equator has also the advantage of immunity from becoming involved in the actual center itself, inasmuch as there is a distinct tendency on the part of the latter to move away from the equator. For these reasons the more remote semicircle has been called the *dangerous*, the less remote the *navigable*.

486. Maneuvering.—A vessel suspecting the dangerous proximity of a tropical cyclonic storm should lie-to for a time on the starboard tack to locate the center by observing shifts of the wind and the behavior of the barometer. If the former holds steady and increases in force, while the latter falls rapidly, say at a greater rate than 0.03 of an inch per hour, the vessel is probably on the track of the storm and in advance of the center. In this position the proper step (providing, of course, that sea room permits) is to run, keeping the wind, in the northern hemisphere, at all times well on the starboard quarter; in the southern hemisphere, well on the port; and thus constantly increasing the distance to the storm center. The same rule holds good if the observation places the vessel at but a scant distance within the forward quadrant of the dangerous semicircle. Here, too, the natural course will be to seek the navigable semicircle of the storm, even though such a course involves crossing the track in advance of the center, always exercising due caution to keep the wind from drawing too far aft.

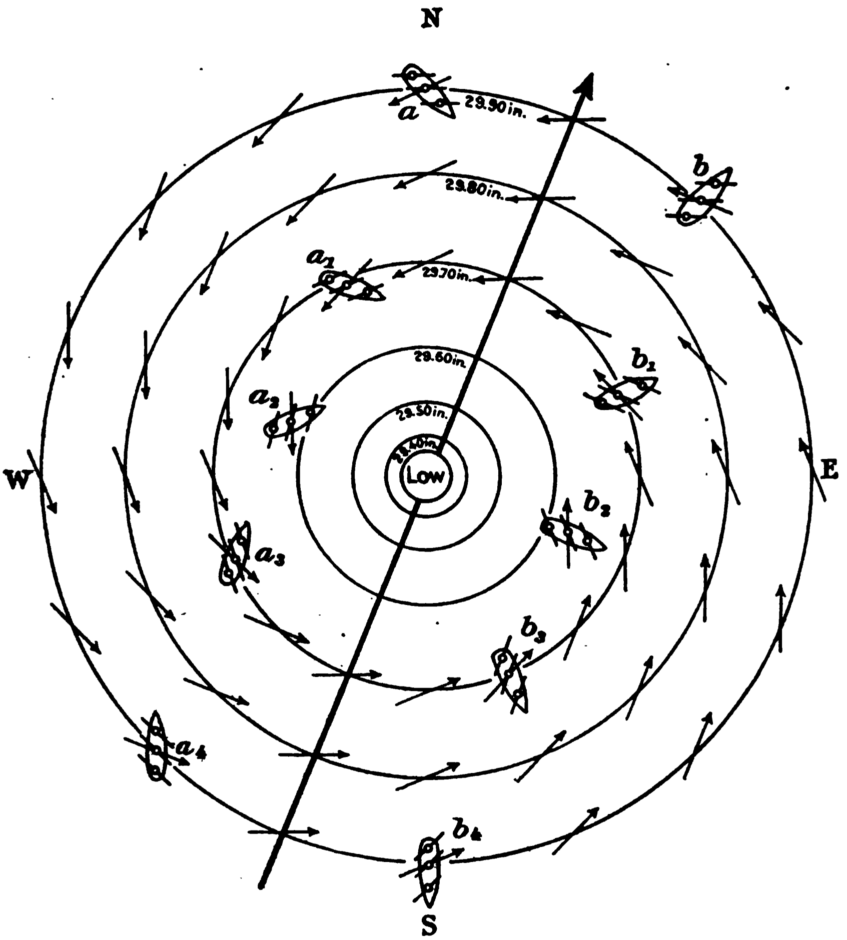


FIG. 75.

The critical case is that of a vessel which finds herself in the forward quadrant of the dangerous semicircle and at a considerable distance from the track, for here the shifts of the wind are sluggish and the indications of the barometer are undecided, both causes conspiring to render the bearing of the center doubtful. If, upon heaving to, the barometer becomes stationary, the position should be maintained until indications of a rise are apparent, upon which the course may be resumed with safety and held as long as the rise continues. If, however, the barometer falls, a steamer should make a run to the NNE. or NE. (southern hemisphere, SSE. or SE.), keeping the wind and sea a little on the port (southern hemisphere, starboard) bow, and using such speed as will at least keep the barometer stationary. Such a step will in general be attended with the assurance that the present weather conditions will in any case grow no worse. For a sailing vessel, unable to stand closer to the wind than six points, the last maneuver will be impossible, and driven to leeward by wind, sea, and current, she may be compelled to cross the track immediately in advance of the center, or may even become involved in the center itself. In this extremity the path of the storm center during the past twenty-four hours should be laid down on a diagram as accurately as the observations permit, and the line prolonged for some distance beyond the present position of the center. Having assumed an average rate of progress for the center, its probable position on the line should be frequently and carefully plotted, and the handling of the vessel should be in accordance with the diagram.

487. SUMMARY OF RULES.—The following summary comprises the rules of maneuvering, so far as they may be made general:

NORTHERN HEMISPHERE.

In the Right or Dangerous Semicircle.—Steamers bring the wind on the starboard bow, and make as much way as possible; if obliged to heave to, do so head to sea. Sailing vessels haul by the wind on the starboard tack and carry sail as long as possible; if obliged to heave to, do so on the starboard tack.

In the Left or Navigable Semicircle.—Bring the wind on the starboard quarter, note the course, and hold it; if obliged to heave to, do so on the port tack, unless in a steamer which behaves better when hove to stern to the sea.

On the Storm Track in Front of the Center.—Bring the wind two points on the starboard quarter, and, holding this course, run for the Left Semicircle; if obliged to heave to, do so on the port tack, unless in a steamer which behaves better when hove to stern to the sea.

On the Storm Track in Rear of the Center.—Avoid the center by the best practicable route, having due regard to the tendency of cyclones to recurve to the northward and eastward.

SOUTHERN HEMISPHERE.

In the Left or Dangerous Semicircle.—Steamers bring the wind on the port bow, and make as much way as possible; if obliged to heave to, do so head to sea. Sailing vessels haul by the wind on the port tack, and carry sail as long as possible; if obliged to heave to, do so on the port tack.

In the Right or Navigable Semicircle.—Bring the wind on the port quarter, note the course, and hold it; if obliged to heave to, do so on the starboard tack, unless in a steamer which behaves better when hove to stern to the sea.

On the Storm Track in Front of the Center.—Bring the wind two points on the port quarter, and, holding this course, run for the right semicircle; if obliged to heave to, do so on the starboard tack, unless in a steamer which behaves better when hove to stern to the sea.

On the Storm Track in Rear of the Center.—Avoid the center by the best practicable route, having due regard to the tendency of cyclones to recurve to the southward and eastward.

The application of these rules for the various directions of the wind is shown in the following table:

Storm Table, Northern Hemisphere.

Direction of wind.	Direction of center.	Observer facing along storm track.			
		If wind shifts toward the right.	If wind shifts toward the left.	If wind steady with falling barometer.	If wind steady with rising barometer.
North.	ESE.	Steamers bring wind on starboard bow and make as much way as possible; if obliged to heave to, do so head to sea. Sailing vessels haul by wind on starboard tack and carry sail as long as possible; if obliged to heave to, do so on starboard tack.	Run SSW. Hold course [a] as long as possible; if obliged to heave to, do so on port tack.	Run SSW. Hold course as long as possible; if obliged to heave to, do so on port tack.	Run SSW. Hold course [a] as long as possible; if obliged to heave to, do so on starboard tack.
NNE.	SE.		Run SW.	Run SW.	Run SW.
NE.	SSE.		Run WSW.	Run WSW.	Run WSW.
ENE.	South.		Run West.	Run West.	Run West.
East.	SSW.		Run WNW.	Run WNW.	Run WNW.
ESE.	SW.		Run NW.	Run NW.	Run NW.
SE.	WSW.		Run NNW.	Run NNW.	Run NNW.
SSE.	West.		Run North.	Run North.	Run North.
South.	WNW.		Run NNE.	Run NNE.	Run NNE.
SSW.	NW.		Run NE.	Run NE.	Run NE.
SW.	NNW.		Run ENE.	Run ENE.	Run ENE.
WSW.	North.		Run East.	Run East.	Run East.
West.	NNE.		Run ESE.	Run ESE.	Run ESE.
WNW.	NE.		Run SE.	Run SE.	Run SE.
NW.	ENE.		Run SSE.	Run SSE.	Run SSE.
NNW.	East.		Run South.	Run South.	Run South.

[a] Courses given are for wind two points on starboard quarter, but it is preferable to take wind broad on quarter if possible.

Storm Table, Southern Hemisphere.

Direction of wind.	Direction of center.	Observer facing along storm track.			
		If wind shifts toward the right.	If wind shifts toward the left.	If wind steady with falling barometer.	If wind steady with rising barometer.
North.	WSW.	Run SSE. Hold course [a] as long as possible; if obliged to heave to, do so on starboard tack.	Steamers bring wind on port bow and make as much way as possible; if obliged to heave to, do so head to sea. Sailing vessels haul by wind on port tack, and carry sail as long as possible; if obliged to heave to, do so on port tack.	Run SSE. Hold course as long as possible; if obliged to heave to, do so on starboard tack.	Run SSE. Hold course [a] as long as possible; if obliged to heave to, do so on port tack.
NNE.	West.	Run South.		Run South.	Run South.
NE.	WNW.	Run SSW.		Run SSW.	Run SSW.
ENE.	NW.	Run SW.		Run SW.	Run SW.
East.	NNW.	Run WSW.		Run WSW.	Run WSW.
ESE.	North.	Run West.		Run West.	Run West.
SE.	NNE.	Run WNW.		Run WNW.	Run WNW.
SSE.	NE.	Run NW.		Run NW.	Run NW.
South.	ENE.	Run NNW.		Run NNW.	Run NNW.
SSW.	East.	Run North.		Run North.	Run North.
SW.	ESE.	Run NNE.		Run NNE.	Run NNE.
WSW.	SE.	Run NE.		Run NE.	Run NE.
West.	SSE.	Run ENE.		Run ENE.	Run ENE.
WNW.	South.	Run East.		Run East.	Run East.
NW.	SSW.	Run ESE.		Run ESE.	Run ESE.
NNW.	SW.	Run SE.		Run SE.	Run SE.

[a] Courses given are for wind two points on port quarter, but it is preferable to take wind broad on quarter if possible.

488. EXTRA-TROPICAL CYCLONIC STORMS.—On turning to the cyclones of temperate latitudes, we find many features in which they resemble those of the torrid zone, but certain other features in which they differ. Their fundamental resemblance to tropical cyclones is seen in their incurving winds, forming an inflowing left-handed spiral about the center of low pressure in the northern hemisphere, an inflowing right-handed spiral in the southern. The intensity of these winds varies with the depth of the barometric depression. The depression itself, however, in place of covering a few miles, as is the case in the tropics, will frequently have a diameter of several hundred or even a thousand miles, and for some distance around the center the gradients will have a tolerably strong value. For this reason there is less concentration of violence close to the center, and the calm and clear central space, or "eye," is seldom sharply developed, although it is not uncommon to discover a gradual weakening or failing

of the winds, and sometimes even an imperfect breaking away of the clouds as the central area passes over the observer. The form of tropical cyclones as defined by their isobaric lines is nearly circular. Extra-tropical cyclones are as a rule less symmetrical, and their isobars are often elongated into an oval form, the longer axis of the oval trending (in the northern hemisphere) between north and east—about, therefore, in the direction of progression. The steepest gradients, and consequently the strongest winds, are apt to be found on the equatorial and westerly sides of the depression.

Extra-tropical cyclones generally follow an easterly course, inclining somewhat toward the pole; but they occasionally turn to one side or the other, become stationary, or even move backward. The velocity of progression varies from 15 to 40 miles an hour. If they exist as independent barometric depressions, with strong upward gradients on all sides of the center, the cyclonic circulation will be complete, the wind shifting with the sun for an observer situated in the equatorial semicircle of the storm, against the sun for an observer situated in the polar semicircle.

Important among these extra-tropical cyclonic disturbances are the pamperos of the Argentine coast. These storms are primarily caused by the approach and passage eastward of an area of low pressure, around which the winds circulate spirally in a right-handed direction. They vary in strength and duration from a squall to a gale of great violence. Although preceded by the indications which characterize the approach of cyclonic storms in general, yet they usually break with such suddenness, in a shift of wind from the northward to the southwestward, that they may become particularly dangerous from this cause alone. They usually continue to blow and die out in the southwest quadrant.

489. Storms Along the Transatlantic Steamship Routes.—The storms which are so frequently met during the winter season along the steamship routes between America and Europe are not, as a rule, due to central barometric depressions but to depressions having a trough or V shape, which extend southerly from the extensive permanent area of low pressure having its center in the vicinity of Iceland. They are not attended by complete cyclonic circulations, inasmuch as the polar gradients which would otherwise give rise to easterly winds on this polar side are lacking. Their approach is heralded by a gradual hauling of the wind to southward, which is later followed (at the time of passage of the central line of the trough) by a change to NW., accompanied by heavy rain squalls and a rapid increase in force. The general distribution of pressure and the surrounding winds are shown in figure 76. The changes in wind and pressure ensue much more rapidly in the case of a westward-bound vessel than in that of one eastward bound, the rate at which the observer and the depression approach each other being in the former case the sum of his own westward velocity and the eastward velocity of the trough, in the latter case the difference of these velocities.

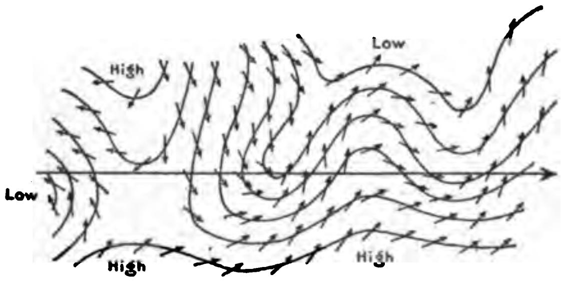


FIG. 76.

CHAPTER XX.

TIDES.

490. Definitions.—Tidal phenomena present themselves to the observer under two aspects—as alternate elevations and depressions of the sea, and as recurrent inflows and outflows of streams. The word *tide,* in common and general usage, is made to refer without distinction to both the vertical and horizontal motions of the sea, and confusion has sometimes arisen from this double application of the term; in its strict sense, this word may be used only with reference to the changes of elevation, while the recurrent streams are properly distinguished as *tidal currents.*

The tide rises until it reaches a maximum height called *high water* or *high tide,* and then falls to a minimum level called *low water* or *low tide;* that period at high or low water marking the transition between the tides, during which no vertical change can be detected, is called *stand.*

Of the tidal currents, that which arises from a movement of the water in a direction, generally speaking, from the sea toward the land, is called *flood,* and that arising from an opposite movement, *ebb;* the intermediate period between the currents, during which there is no horizontal motion, is distinguished as *slack. Set* and *drift* are terms applicable to the tidal currents, the first referring to the direction and the second to the velocity.

Care should be taken to avoid confusing the terms relating to tides with those which relate to tidal currents.

491. Cause.—The cause of the tides is the periodic disturbance of the ocean from its position of equilibrium brought about through the periodic differences of attraction upon the water particles of the earth, by the moon, and to lesser degree, by the sun, on account of their relative periodic movements. The tide-producing force of the moon upon a particle of unit mass on the surface of the earth is the difference between the moon's attraction upon the given unit mass and the moon's attraction upon the entire earth; and it is likewise with the sun, only the magnitude of the mean tide-producing force is in this case reduced to about two-fifths of the tide-producing force of the moon, because of the comparative remoteness of the sun from the earth.

A particle which has a tide-producing body in its zenith or in its nadir experiences, as the result of the attraction of the tide-producing body, an effect only in the vertical direction as if the intensity of gravity were momentarily lessened; and a particle which has the tide-producing body in its horizon, being then practically at the same distance from the tide-producing body as the center of the earth, experiences, as the result of the attraction of the tide-producing body, an effect which is practically all in the vertical direction as if the intensity of gravity were momentarily increased. But when the tide-producing body is in any other situation with reference to an attracted particle, the attraction is partly directed in a vertical line toward the center of the earth and partly in a horizontal direction along the surface of the earth. The vertical components of the attractions of the tide-producing bodies can not create any sensible disturbance on the existing oceans; but the horizontal components of such attractions, tending to produce horizontal movements oscillating back and forth on the surface of the earth, are effective in the production of the tides, and, by acting upon portions of the oceans that are susceptible of taking up stationary oscillations in approximate unison with the period of the tide-producing forces, give rise to the dominant tides.

The peculiarities that characterize the tides of many localities are caused by modifications resulting from reflections and interferences suffered by the dependent waves generated by the dominant tides. Theory is not yet sufficiently advanced to render practicable the prediction of the tides where no observations have been made;

but by theory, supplemented by the observation of actual tidal conditions in a given locality during a certain period of time, very accurate predictions of the time and height of the tides can be made for that locality.

492. Establishment.—High and low water occur, on the average of the twenty-eight days comprising a lunar month, at about the same intervals after the transit of the moon over the meridian. These nearly constant intervals, expressed in hours and minutes, are known, respectively, as the *high water lunitidal interval* and *low water lunitidal interval.*

The interval between the moon's meridian passage at any place and the time of the next succeeding high water, as observed on the days when the moon is at full or change, is called the *vulgar* (or *common*) *establishment* of that place, or, sometimes, simply the *establishment.* This interval is frequently spoken of as the *time of high water on full and change days* (abbreviated "H. W. F. & C."); for since, on such days, the moon's two transits (upper and lower) over the meridian occur about midnight and noon, the vulgar establishment then corresponds closely with the local times of high water. When more extended observations have been made, the average of all high water lunitidal intervals for at least a lunar month is taken to obtain what is termed, in distinction to the vulgar establishment, the *corrected establishment* of the port, or *mean high water lunitidal interval.* In defining the tidal characteristics of a place some authorities give the corrected establishment, and others the vulgar establishment, or "high water, full, and change;" calculations based upon the former will more accurately represent average conditions, though the two intervals seldom differ by a large amount.

Having determined the time of high water by applying the establishment to the time of moon's transit, the navigator may obtain the time of low water with a fair degree of approximation by adding or subtracting $6^h\ 13^m$ (one-fourth of a mean lunar day); but a closer result will be given by applying to the time of transit the *mean low water lunitidal interval,* which occupies the same relation to the time of low water as the mean high water lunitidal interval, or corrected establishment, does to the time of high water.

493. Range.—The *range* of the tide is the difference in height between low water and high water. This term is often applied to the difference existing under average conditions, and may in such a case be designated as the *mean range* or *mean rise and fall* to distinguish it from the *spring range* or *neap range,* which are the ranges at spring and neap tides, respectively.

494. Spring and Neap Tides.—At the times of new and full moon the relative positions of sun and moon are such that the high water produced by one of those bodies occurs at the same time as that produced by the other, and so also with the low waters; the tides then occurring, called *spring tides,* have a greater range than any others of the lunar month, and at such times the highest high tides as well as the lowest low tides are experienced, the tidal range being then at its maximum. At the first and third quarters of the moon the positions are such that the high tide due to one body occurs at the time of the low tide due to the other, so that the two actions are opposed; this causes the *neap tides,* which are those of minimum range, the high waters being lower and the low waters higher than at other periods of the month.

Since the horizontal motion of the water depends directly upon the rise and fall of the tides it follows that the currents will be greatest at springs and least at neaps.

The effect of the moon's being at full or change is not felt at once in all parts of the world, and the greatest range of tides does not generally occur until one or two days thereafter; thus, on the Atlantic coast of North America, the highest tides are experienced one day, and on the Atlantic coast of Europe two days, afterwards, though on the Pacific coast of North America they occur nearly at full and change.

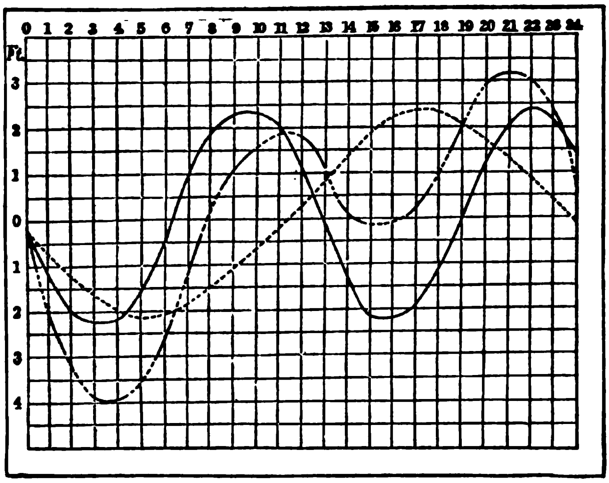
495. The nearer the moon is to the earth the stronger is its attraction, and as it is nearest in perigee, the tides will be larger then on that account, and consequently less in apogee. For a like reason, the tides will be increased by the sun's action when the earth is near its perihelion, about the 1st of January, and decreased when near its aphelion, about the 1st of July.

496. The height of the tides at any place may undergo modification on account of strong prevailing winds or abnormal barometric conditions, a wind blowing off the shore or a high barometric tending to reduce the tides, and the reverse. The effect of atmospheric pressure is to create a difference of about 2 inches in the height of tide for every tenth of an inch of difference in the barometer.

497. **Priming and Lagging.**—The *tidal day* is the variable interval, averaging $24^h\ 50^m$, between two alternate high or low waters. The amount by which corresponding tides grow later day by day—that is, the amount by which the tidal day exceeds 24^h—is called the *daily retardation*. When the sun's tidal effect is such as to shorten the lunitidal intervals, thus reducing the length of the tidal day and causing the tides to occur earlier than usual, there is said to be a *priming* of the tide; when, from similar causes, the interval is lengthened, there is said to be a *lagging*.

498. **Types of Tides.**—The observed tide is not a simple wave; it is a compound of several elementary undulations, rising and falling from the same common plane, of which two can be distinguished and separated by a simple grouping of the data. These two waves are known as the *semidiurnal* and the *diurnal* tides, because the first, if alone, would give two high and two low waters in a day, while the second would give but one high and one low water in an equivalent period of time. In nearly all ports these two tides coexist, but the proportion between them varies remarkably for different seas. The effect of the combination of these two types of tide is to produce a *diurnal inequality,* both in the height of two consecutive high or low waters, and in the intervals of time between their occurrence. The height of the diurnal wave may be regarded as reaching a maximum fortnightly, soon after the moon attains its extreme declination and is therefore near one of the tropics. The tides that then occur are denominated *tropic tides.*

In undertaking to investigate the tides of a port it is important to ascertain as early as possible the form of the tide; that is, whether it resembles the semidiurnal, the diurnal, or the mixed type; because not only may this information be of scientific value, but the knowledge thus gained at the outset will enable the observer to fix upon the best method of keeping his record.



——— Semidiurnal. .....diurnal. ——...—— mixed.

Fig. 77.

499. The type forms referred to are illustrated in the diagram in figure 77, where the waves are plotted in curves, using the times as abscissæ and the heights as ordinates. In this diagram, the curve traced in the full line is a tide wave of the semidiurnal type; that traced by the dotted line one of the diurnal; while the broken line is one of the mixed type, in this case the compound of the two others.

In order to determine the type to which the tide of any port belongs, it is usually only necessary to make hourly observations for a day or two at the date of the moon's maximum declination, and to repeat the series about a week later, when the moon crosses the equator. The reported irregularities of the rise and fall at any place should not deter persons from careful investigation. When analyzed, even the most complicated of tides are found to follow some general law.

500. **Tidal Currents.**—It should be clearly borne in mind by the navigator that the periods of flood and ebb currents do not necessarily coincide with those of rising and falling tides, and that, paradoxical though it may seem at first thought, the inward set of the surface current does not always cease when the water has attained its maximum height, nor the outward set when a minimum height has been reached. Under some circumstances it may occur that stand and slack will be

simultaneous, while other conditions may produce a maximum current at stand, with a maximum rate of rise or fall at slack water.

The varying effects which will be produced according to local conditions may be considered by the comparison of two tidal basins, to one of which the tide wave has access from the sea by a channel of ample capacity, while the other has an entrance that is narrow and constricted. In the first case, the process of filling or emptying the basin keeps pace with the change of level in the sea and is practically completed as soon as the height without becomes stationary; in this case slack and stand occur nearly at the same time, as do flood and rise and ebb and fall. In the second case, the limited capacity of the entrance will not permit the basin to fill or empty as rapidly as the tide changes its level without; hence there is still a difference of level to produce a current when the vertical motion in either direction has ceased on the outside, and for a considerable time after motion in the reverse direction has been in progress; under extreme conditions it may even occur that a common level will not be established until mid-tide, and therefore the surface current at some places will ebb until three hours after low water and flow until three hours after high water.

Localities that partake of the nature of the first case are those upon open coasts and wide-mouthed bights. Examples of the latter class will be found in narrow bays and long channels.

TIMES OF HIGH AND LOW WATER.

501. TIDE TABLES.—The most expeditious, as well as most exact, method of ascertaining the times of high and low water and other features of the tides will be by reference to a *Tide Table,* and every navigator is recommended to provide himself with such a publication. The United States Coast and Geodetic Survey publishes annually, in advance, tables giving, for every day in the year, the predicted time and height of the tides at certain principal ports of the world, and from these, by a simple reduction, the times and heights at a multitude of other ports may readily be obtained; data for ascertaining the tidal currents in certain important regions are also provided. General tide tables are also published by the governments of other maritime nations, and special tables are to be had for many particular localities.

502. Where no tide tables are available, the method of calculation by applying the lunitidal interval to the time of the moon's meridian passage must be resorted to.

To do this, find first the time of the moon's meridian passage, upper or lower, as may be required. The Greenwich mean time of upper transit at Greenwich is given in the Nautical Almanac; the corresponding time of lower transit is most easily found by taking the mean of the two adjacent upper transits; to the Greenwich time of Greenwich transit apply the correction for longitude given in Table 11 (using the daily variation of the moon's meridian passage shown in the Almanac), adding in west and subtracting in east longitude; the result is the local mean time of local transit. Add to this the high-water or low-water lunitidal interval of the port from Appendix IV, according as the time of high or low water may be required. The result is the time sought.

The astronomical date must be strictly adhered to, and in so doing it may be found necessary to employ the time of a lower transit, or the transit of a preceding day, to find the time of the tide in question.

Appendix IV contains, besides the geographical positions of all the more important positions in the world, a series of tidal data relating to many of those places. In such data are comprised the mean lunitidal intervals for high and low water; also, for places where the semi-diurnal type of tide prevails, the tidal range at spring and at neap tides, and for those where the tide is of the diurnal type, the tropic range. An alphabetical index is appended to this table.

The corrected establishment taken from the charts may be substituted for the high-water lunitidal interval of the table; or, with only slight variation in the results, the vulgar establishment (H. W. F. & C.) may be employed.

Example: Find the times of the high and low waters at the New York Navy Yard, occurring next after noon on April 15, 1916.

G. M. T. of Gr. upper transit,		14^{d}	9^{h}	21^{m}
G. M. T. of Gr. upper transit,		15	10	05
		2)29	19	26
G. M. T. of Gr. lower transit		14	21	43
Corr. for +74° Long. (Tab. 11),	+			9
L. M. T. of local lower transit		14	21	52

Transit (lower),	14^{d}	21^{h}	52^{m}
H. W. Lun. Int. (App. IV),		8	44
L. M. T., H. W.,	15	6	36
	Apr. 15, 6.36 p. m.		

Transit (lower),	14^{d}	21^{h}	52^{m}
L. W. Lun. Int. (App. IV),		2	49
L. M. T., L. W.,	15	0	41
	Apr. 15, 12.41 p. m.		

Example: Find the time of high water at the Presidio, San Francisco, Cal., on the evening of February 17, 1916.

G. M. T. of Gr. upper transit,		16^{d}	10^{h}	37^{m}
G. M. T. of Gr. upper transit,		17	11	23
		2)33	22	00
G. M. T. of Gr. lower transit,		16	23	00
Corr. +122° Long. (Tab. 11),	+			16
L. M. T. local lower transit,		16	23	16
H. W. Lun. Int. (App. IV),			11	43
L. M. T., H. W.,		17	10	59
		Feb. 17, 10.59 p. m.		

Example: Find the time of low water at Singapore on the night of May 21, 1916.

G. M. T. of Gr. upper transit,		20^{d}	15^{h}	29^{m}
G. M. T. of Gr. upper transit,		21	16	28
		2)42	7	57
G. M. T. of Gr. lower transit,		21	3	59
Corr. for −104° Long. (Tab. 11),	−			17
L. M. T. of local lower transit,		21	3	42
L. W. Lun. Int. (App. IV)	+		4	02
L. M. T., L. W.,		21	7	44
		May 21, 7.44 p. m.		

Example: Find the time of morning high water and afternoon low water at Gibraltar on June 19, 1916.

G. M. T. of Gr. upper transit,		18^{d}	15^{h}	12^{m}
Corr. +5° Long. (Tab. 11),	+			01
L. M. T. of local transit,		18	15	13
H. W. Lun. Int. (App. IV),			1	35
L. M. T., H. W.,		18	16	48
		June 19, 4.48 a. m.		

G. M. T. of Gr. upper transit,		18^{d}	15^{h}	12^{m}
G. M. T. of Gr. upper transit,		19	16	05
		2)38	7	17
G. M. T. of Gr. lower transit,		19	3	39
Corr. for +5° Long. (Tab. 11),	+			01
L. M. T. of local lower transit,		19	3	40
L. W. Lun. Int. (App. IV),			7	55
L. M. T., L. W.,		19	11	35
		June 19, 11.35 p. m.		

TIDAL OBSERVATIONS.

503. Since navigators will frequently have opportunity to observe tidal conditions, either in connection with a hydrographic survey or otherwise, at places where existing knowledge of the tides is incomplete, an understanding of the methods employed in tidal observations may be important.

504. Tides.—For the proper study of tides, frequent and continuous observations are necessary; it will not suffice to observe the heights of the high and low waters only, even if they present themselves as distinct phases, but the whole tidal curve for each day should be developed by recording the height of water at intervals, which, preferably, should not exceed thirty minutes. Observations, to be complete, must cover a whole lunar month; or, if it be impracticable to observe the tides at night, the day tides of two lunar months may be substituted.

505. When made for the purposes of a hydrographic survey, the tidal observations are used to correct the soundings, and care must be taken to make sure that the gauge is placed in a situation visited by the same form of tide as that which occurs at the place where soundings are being made. It will not answer, for instance, to correct the soundings upon an inlet bar by tidal observations made within the lagoon with which this inlet communicates, because the range of the tide within the lagoon is less than upon the outside coast. A partial obstruction, like a bridge, or a natural contraction of the channel section, while it may not reduce the total range of the tide or materially affect the time of high or low tides, will alter the relative heights above and below at intermediate stages, so that the hydrographer must be careful to see that no such obstruction intervenes between his field of work and the gauge.

506. Tidal Currents.—Observations for tidal currents should be made with the same regularity as for tides; the intervals need not ordinarily be more frequent than once in every half hour. They should always be made at the same point or points, which should be far enough from shore to be representative of the conditions prevailing in the navigable waters. The ordinary log may be employed for measuring the current, but it is better to replace the chip by a pole weighted to float upright at a depth of about fifteen feet; the line should be a very light one, and buoyed at intervals by cork floats to keep it from sinking; the set of the current should be noted by a compass bearing of the direction of the pole at the end of the observation.

507. Record.—The record of observations should be kept clearly and in complete form. It should include a description of the locality of observation, the nature of gauge and of instruments used for measuring currents, and the exact position of both tidal and current stations, together with situation and height of bench mark. The time of making each observation should be shown, and data given for reduction to some standard time. In extended tidal observations the meteorological conditions should be carefully recorded, the instruments used for the observations being properly compared with standards.

508. There are frequently remarkable facts in reference to tides and currents to be obtained from persons having local knowledge; these should be examined and recorded. The date and circumstances of the highest and lowest tides ever known form important items of information.

509. Planes of Reference.—The *plane of reference* is the plane to which soundings and tidal data are referred. One of the principal objects of observing tides when making a survey is to furnish the means for reducing the soundings to this plane. Four planes of reference are used; namely, mean low water, mean low water springs, mean lower low waters, and the harmonic or Indian tide plane.

Mean low water is a plane whose depression below mean sea level corresponds with half the mean semidiurnal range, while the depression of *mean low water springs* corresponds with half the mean range of spring tide; *mean lower low water* depends upon the diurnal inequality in high and low water; the *harmonic* or *Indian tide plane* was adopted as a convenient means of expressing something of an approximation to the level of low water of ordinary spring tides, but where there is a large diurnal inequality in low waters it falls considerably below the true mean of such tides.

As these planes may differ considerably, it is important to ascertain which plane of reference is adopted before making use of any chart or considering data concerning the tides.

510. The tides are subject to so many variations dependent upon the movements of the sun and moon, and to so many irregularities due to the action of winds and river outflows, that a very long series of observations would be necessary to fix any natural plane. In consideration of this, and keeping in view the possibilities of repetitions of the surveys or subsequent discoveries within the field of work, it is necessary to define the position of the plane of reference which has resulted from any series of observations. This is done by leveling from the tide gauge to a permanent *bench*, precisely as if the adopted plane were arbitrary.

511. Bench Mark.—The plinth of a lighthouse, the water table of a substantial building, the base of a monument, and the like, are proper benches; and when these are not within reach a mark may be made on a rock not likely to be moved or started by the frost, or, if no rock naturally exists in the neighborhood, a block of stone buried below the reach of frost and plowshare should be the resort. When a bench is made on shore it should be marked by a circle of 2 or 3 inches diameter with a cross in the center indicating the reference point. The levelings between this point and the gauge should be run over twice and the details recorded. A bench made upon a wharf or other perishable structure is of little value, but in the absence of permanent objects it is better than nothing. The marks should be cut in, if on stone, and if on wood, copper nails should be used. The bench must be sketched and carefully described, and its location marked on the hydrographic sheet, with a statement of the relative position of the plane of reference.

512. The leveling from the bench mark to the tide gauge may be done, when a leveling instrument is not available, by measuring the difference of height of a number of intermediate points by means of a long straight-edged board, held horizontal by the aid of a carpenter's spirit level, or even a plummet square, taking care to repeat each step with the level inverted end for end. A line of sight to the sea horizon, when it can be seen from the bench across the tide staff, will afford a level line of sufficient accuracy, especially when observed with the telescope. It may often be convenient to combine these methods.

513. TIDE GAUGES.—The *Staff Gauge* is the simplest device for measuring the heights of tides, and in perfectly sheltered localities it is the best. It consists of a vertical staff graduated upward in feet and tenths, and so placed that its zero shall lie below the lowest tides. The same gauge may also be used where the surface is rough, if a glass tube with a float inside is secured alongside of the staff, care being taken to practically close the lower end of the tube so as to exclude undulations; readings may also be made by noting the point midway between the crest and trough of the waves.

A staff gauge should always be erected for careful tidal observations, even where other classes of gauge are to be employed, as it furnishes a standard for comparison of absolute heights, and also serves to detect any defects in the mechanical details upon which all other gauges are to a greater or less extent dependent.

514. Where there is considerable swell, and where, from the situation of the gauge or the great range of the tide (making it inconvenient for the observer to see the figures in certain positions) the staff gauge can not be used, recourse must be had to the *Box Gauge*. This gauge consists of a vertical box, closed at the bottom, with a few small holes in the lower part which admit sufficient water to keep the level within equal to the mean level without but which do not permit the admission of water with sufficient rapidity to be affected by the waves. Within the box is a copper float; in some cases this float carries a graduated vertical rod whose position with reference to a fixed point of the box affords a measure for the height of the water; in other gauges of this class the float is attached to a wire or cord which passes over pulleys and terminates in a counterpoise whose position on a vertical graduated scale shows the height of tide.

515. An *Automatic Gauge* requires a box and float such as has just been described. The motion of the float in rising and falling with the tide is communicated to a pencil which rests upon a moving sheet of paper; uniform motion is imparted to the paper by the revolution of a cylinder driven by clockwork; the motion of the pencil due to the tide is in a direction perpendicular to the direction of motion of the paper, and a curve is thus traced, of which one coordinate is time and the other height. The paper, which is usually of sufficient length to contain a month's record, is paid out from one cylinder, passes over a second whereon it receives the record and is rolled upon a third cylinder, which thus contains the completed tidal sheet.

This gauge, besides giving a perfectly continuous record, has the further merit of requiring but little of the observer's time. But its indications, both of time and heights, should be checked by occasional comparisons with the standard clock and the staff gauge, the readings of which should be noted by hand at appropriate points of the graphic record.

A newer type of automatic gauge prints the date, the time, and the stage of the tide every five minutes on a paper tape.

CHAPTER XXI.

OCEAN CURRENTS.

516. An *ocean current* is a progressive horizontal motion of the water occurring throughout a region of the ocean, as a result of which all bodies floating therein are carried with the stream.

The *set* of a current is the direction toward which it flows, and its *drift*, the velocity of the flow.

517. Cause.—The principal cause of the superficial ocean currents is the wind. Every breeze sets in motion, by its friction, the surface particles of the water over which it blows; this motion of the upper stratum is imparted to the stratum next beneath, and thus the general movement is communicated, each layer of particles acting upon the one below it, until a current is established. The direction, depth, strength, and permanence of such a current will depend upon the direction, steadiness, and force of the wind; all, however, subject to modification on account of extraneous causes, such as the intervention of land or shoals and the meeting of conflicting currents.

A minor cause in the generation of ocean currents is the difference in density of the sea water in different regions, as a result of which a set is produced from the more dense toward the less dense, in the effort to establish equilibrium of pressure; the difference of density may be due to temperature, the warmer water near the equator being less dense than the colder water of higher latitudes; or it may be created by a difference in the amount of contained saline matter, resulting from evaporation, freezing, or other causes. Another minor factor that may have influence upon ocean currents is the difference of pressure exerted by the atmosphere upon the water in different regions. But neither of the last-mentioned causes may be regarded as of great importance when compared with the influence, direct and indirect, of the wind.

518. Submarine Currents.—In any scientific investigation of the circulation of ocean waters it is necessary to take account of the submarine currents as well as those encountered upon the surface; but for the practical purposes of the navigator the surface currents alone are of interest.

519. Methods of Determination.—The methods of determining the existence of a current, with its set and drift, may be divided into three classes; namely, (*a*) by observations from a vessel occupying a stationary position not affected by the current; (*b*) by comparison of the position of a vessel under way as given by observation with that given by dead reckoning; and (*c*) by the drift of objects abandoned to the current in one locality and reappearing in another.

520. Of these methods the first named, by observations from a vessel at anchor, is by far the most accurate and reliable, but being possible only under special circumstances is not often available. The most valuable information about ocean currents being that which pertains to conditions in the open sea, the great depths there existing usually preclude the possibility of anchoring a vessel; ships especially fitted for the purpose have at times, however, carried out current observations with excellent results; the most notable achievements in this direction are those of the survey of the Gulf Stream, made by United States naval officers acting under the Coast and Geodetic Survey, during which the vessel was anchored and observations were made in positions where the depths reached to upward of 2,000 fathoms.

521. The method of determining current from a comparison of positions obtained respectively by observation and by dead reckoning is the one upon which our knowledge must largely depend. This method is, however, always subject to some inaccuracy, and the results are frequently quite erroneous, for the so-called current is thus made to embrace not only the real set and drift, but also the errors of observation and dead reckoning. In the case of a modern steamer accurately steered and equipped with good instruments for determining the speed through the water as well as the position by astronomical observations, the current may be arrived at by this method with a fairly close degree of accuracy. It is not always possible, however, to keep an exact reckoning, and this is especially true in sailing vessels, where the conditions render it difficult to determine correctly the position by account; this source of error may be combined with faulty instrumental determinations, giving apparent currents differing widely from those that really exist.

522. Much useful knowledge regarding ocean currents has been derived from the observed drift of objects from one to another locality. This is true not only of the bottles thrown overboard from vessels with the particular object of determining the currents, but also of derelicts, drifting buoys, and pieces of wreckage, which fulfill a similar mission. The deductions to be drawn from such drift are of a general nature only. The point of departure, point of arrival, and elapsed time are all that are positively known. The route followed and the set and drift of current at different points are not indicated, and in the case of objects floating otherwise than in a completely submerged condition account must be taken of the fact that the drift is influenced by the wind. But even this general information is of great value in researches as to ocean currents, and navigators who desire to aid in the work of investigation may do so by throwing overboard, from time to time, sealed bottles containing a statement of date and position at which they are launched.

523. CURRENTS OF THE ATLANTIC OCEAN.—A consideration of the currents of the Atlantic most conveniently begins with a description of the *Equatorial Currents*. The effect of the northeast and southeast trade winds is to form two great drift currents, setting in a westerly direction across the Atlantic from Africa toward the American continent, whose combined width covers at times upward of fifty degrees of latitude. These are distinguished as the *Northern* or *Southern Equatorial Currents*, according as they rise from the trade winds of the northern or southern hemisphere.

Of the two, the Southern Equatorial Current is the more extensive. It has its origin off the continent of Africa south of the Guinea coast, and begins its flow with a daily velocity that averages about 15 miles; it maintains a general set of west, the portion near the equator acquiring later, however, a northerly component, while the drift steadily increases until, on arriving off the South American coast, a rate of 60 miles is not uncommon. At Cape San Roque the current bifurcates, the main or equatorial branch flowing along the Guiana coast, while the other branch is deflected to the southward.

The Northern Equatorial Current originates to the northward of the Cape Verde Islands and sets across the ocean in a direction that averages due west; though parallel to the corresponding southern drift, its velocity is not so high.

524. Between the Northern and Southern Equatorial Currents is found the *Equatorial Counter Current* setting to the eastward under the propelling force of the southwest monsoon, which prevails over an elongated area of varying extent lying north of the equator and stretching westward from the southwestern part of the salient extension of the continent of Africa. The extent and strength of this current thus varies with the seasonal extent of the monsoon area, being a maximum in July and August, when its effect is apparent to the westward of the fiftieth meridian of west longitude, while at its minimum, in November and December, its influence is but slight and prevails for only a limited distance from the African coast.

525. To the westward of the region of the Equatorial Counter Current the North and the South Equatorial Currents unite. A large part of the combined stream flows into the Caribbean Sea through the various passages between the Windward Islands, takes up a course first to the westward and then to the northward and westward, finally arriving off the extremity of the peninsula of Yucatan; from here some of the water follows the shore line of the Gulf of Mexico, while another portion passes directly toward the north Cuban coast; by the reuniting of these two branches in the Straits of Florida there is formed the most remarkable of all ocean currents—the Gulf Stream.

From that portion of the combined equatorial currents which fails to find entrance to the Caribbean Sea a current of moderate strength and volume takes its course along the north coasts of Porto Rico, Haiti, and Cuba, flows between the last-named island and the Bahamas, and enters the Gulf Stream off the Florida coast, thus adding its waters to those of the main branch of the Equatorial Current which have arrived at the same point by way of the Caribbean, the Yucatan Passage, and the Gulf.

526. The *Gulf Stream*, which has its origin, as has been described, in the Straits of Florida, and receives an accession from a branch of the Equatorial Current off the Bahamas, flows in a direction that averages true north as far as the parallel of

31°, then curves sharply to ENE. until reaching the latitude of 32°, when a direction a little to the north of NE. is assumed and maintained as far as Cape Hatteras; at this point its axis is about 40 miles, while its inner edge is in the neighborhood of 20 miles off the shore. Thus far in its flow the average position of the maximum current is from 11 to 20 miles outside the 100-fathom curve, disregarding the irregularities of the latter, and the width of the stream—about 40 miles—is nearly uniform. From off Hatteras the stream broadens rapidly and curves more to the eastward, seeking deeper water; its northern limit may be stated to be 60 to 80 miles off Nantucket Shoals and 120 to 150 miles to the southward of Nova Scotia, in which latter place it has expanded to a width of about 250 miles. Farther on its identity as the Gulf Stream is lost, but its general direction is preserved in a current to be described later.

The water of the Gulf Stream is of a deep indigo-blue color, and its junction with ordinary sea water may be plainly recognized; in moderate weather the edges of the stream are marked by ripples; in cool regions the evaporation from its surface, due to difference of temperature between air and water, is apparent to the eye; the stream carries with it a quantity of weed known as "gulf weed," which is familiar to all who have navigated it waters.

In its progress from the tropics to higher latitudes the transit is so rapid that time is not given for more than a partial cooling of the water, and it is therefore found that the Gulf Stream is very much warmer than the neighboring waters of the seas through which it flows. This warm water is, however, divided by bands of markedly cooler water which extend in a direction parallel to the axis and are usually found near the edges of the stream of warm water. The most abrupt change from warm to cold water occurs on the inshore side, where the name of the *Cold Wall* has been given to that band which has appeared to some oceanographers to form the northern and western boundary of the stream.

The investigations of Pillsbury tend to prove that the thermometer is only an approximate guide to the direction and velocity of the current. Though it indicates the limits of the stream in a general way, it must not be assumed that the greatest velocity of flow coincides with the highest temperature, nor that the northeasterly set will be lost when the thermometer shows a region of cold sea water.

The same authority has also demonstrated that in the vicinity of the land there is a marked variation in the velocity of current at different hours of the day, which may amount to upward of 2 knots, and which is due to the elevation and depression of the sea as a result of tidal influences, the maximum current being encountered at a period which averages about three hours after the moon's transit. Another effect noted is that at those times when the moon is near the equator the current presents a narrow front with very high velocity in the axis of maximum strength, while at periods of great northerly or southerly declination the front broadens, the current decreasing at the axis and increasing at the edges. These tidal effects are not, however, observed in the open sea.

The velocity of the Gulf Stream varies with the seasons, following the variation in the intensity of the trade winds, to which it largely owes its origin. The drift of the current under average conditions may be stated as follows:

Between Key West and Habana: Mean surface velocity in axis of maximum current, 2½ knots; allowance to be made by a vessel crossing the entire width of the stream, 1.1 knots per hour.

Off Fowey Rocks: Mean surface velocity in axis, 3.5 knots; allowance in crossing, 2½ knots per hour.

Off Cape Hatteras: Mean surface velocity in axis, upward of 2 knots; allowance in crossing the stream, 1½ knots per hour between the 100-fathom curve and a point 40 miles outside that curve.

527. After passing beyond the longitude of the easternmost portions of North America, it is generally regarded that the Gulf Stream, as such, ceases to exist; but by reason of the prevalence of westerly winds the direction of the set toward Europe is continued until the continental shores are approached, when the current divides, one branch going to the northeastward and entering the Arctic regions and the other running off toward the south and east in the direction of the African coast. These currents have received, respectively, the designations of the *Easterly, Northeast,* and *Southeast Drift Currents.*

528. The effect of the currents thus far described is to create a general circulation of the surface waters of the North Atlantic, in a direction coinciding with that of the hands of a watch, about the periphery of a huge ellipse, whose limits of latitude may be considered as 20° N. and 40° N., and which is bounded in longitude by the eastern and western continents. The central space thus inclosed, in which no well-marked currents are observed, and in the waters of which great quantities of the Sargasso or gulf weed are encountered, is known as the *Sargasso Sea*.

529. The Southeast Drift Current carries its waters to the northwest coast of Africa, whence they follow the general trend of the land from Cape Spartel to Cape Verde. From this point a large part of the current is deflected to the eastward close along the upper Guinea coast. The stream thus formed, greatly augmented at certain seasons by the prevailing monsoon and by the waters carried eastward with the Equatorial Counter Current, is called the *Guinea Current*. A remarkable characteristic of this current is the fact that its southern limit is only slightly removed from the northern edge of the west-moving Equatorial Current, the effect being that the two currents flow side by side in close proximity, but in diametrically opposite directions.

530. The *Arctic* or *Labrador Current* sets out of Davis Strait, flows southward down the coasts of Labrador and Newfoundland, and thence southwestward past Nova Scotia and the coast of the United States, being found inshore of the Gulf Stream. It brings with it the ice so frequently met at certain seasons off Newfoundland.

531. *Rennells Current* was formerly represented as a temporary but extensive stream setting at times from the Bay of Biscay toward the west and northwest across the English Channel and to the westward of Cape Clear. The most recent investigations fail to reveal such a feature, but disclose only a narrow current of reaction moving northward along the coast of France when the winds have forced the waters above the usual level at the head of the Gulf of Gascoyne.

532. Of the two branches of the Southern Equatorial Current which are formed by its bifurcation off Cape San Roque, the northern one, setting along the coasts of northeastern Brazil and of Guiana and contributing to the formation of the Gulf Stream, has already been described; the other, known as the *Brazil Current*, flows to south and west, along the southeastern coast of Brazil, as far as the neighborhood of the island of Trinidad; here it divides, one part continuing down the coast and having some slight influence as far as the latitude of 45° S., and the other curving around toward east.

533. The last-mentioned branch of the Brazil Current is called the *Southern Connecting Current* and flows toward the African coast in about the latitude of Tristan da Cunha. It then joins its waters with those of the general northerly current that sets out of the Antarctic region, forming a current which flows to the northward along the southwest African coast and eventually connects with the Southern Equatorial Current, thus completing the surface circulation of the South Atlantic.

534. There is another current whose effects are felt in the Atlantic. It originates in the Pacific and flows around Cape Horn, and will be described in connection with the currents of the Pacific Ocean.

535. CURRENTS OF THE PACIFIC OCEAN.—As in the Atlantic, the waters of the Pacific Ocean, in the region between the tropics, have a general drift toward the westward, due to the effect of the trade winds, the currents produced in the two hemispheres being denominated, respectively, the *Northern* and the *Southern Equatorial Currents*. These are separated, as also in the case of the Atlantic, by an east-setting stream, about 300 miles wide, whose mean position is a few degrees north of the equator, and which receives the name of the *Equatorial Counter Current*.

536. The major portion of the Northern Equatorial Current, after having passed the Marianas, flows toward the eastern coast of Taiwan in a WNW. direction, whence it is deflected northward, forming a current which is sometimes called the *Japan Stream*, but which more frequently receives its Japanese name of Kuroshiwo, or "black stream." This current, the waters of which are dark in color and contain a variety of seaweed similar to "gulf weed," carries the warm tropical water at a rapid rate to the northward and eastward along the coasts of Asia and its offlying islands, presenting many analogies to the Gulf Stream of the Atlantic.

The limits and volume of the Kuroshiwo vary according to the monsoon, being augmented during the season of southwesterly winds and diminished during the prevalence of those from northeast. The current sets to the north along the east coast of Taiwan (Formosa), and in about latitude 26° N. changes its course to northeast, arriving at the extreme southwestern point of Japan by a route to westward of the Sakishima and Nansei Shoto. A branch makes off from the main stream to follow northward along the west coast of Japan, entering the Sea of Japan by the Tsushima Kaikyo; but the principal current bends toward the east, flows through Osumi Kaikyo and the passages between the Tokara Gunto, and runs parallel to the general trend of the south shores of the Japanese islands of Kiushu, Shikoku, and Honshu, attaining its greatest velocity between Bungo Suido and Kii Suido, where its average drift is between 2 and 3 knots per hour. Continuing beyond the southeastern extremity of Honshu, the direction of the stream becomes somewhat more northerly, and its width increases, with consequent loss of velocity. In the Kuroshiwo, as in the Gulf Stream, the temperature of the sea water is an approximate, though not an exact, guide as to the existence of the current.

537. Near 146° or 147° E. and north of the fortieth parallel the Kuroshiwo divides into two parts. One of these, called the *Kamchatka Current*, flows to the northeast in the direction of the Aleutian Islands, and its influence is felt to a high latitude. The second branch continues as the main stream, and maintains a general easterly direction to the 180th meridian, where it is merged into the north and northeast drift currents which are generally encountered in this region.

538. A cold countercurrent to the Kamchatka Current sets out of Bering Sea and flows to the south and west close to the shores of the Kuril Islands, Hokushu and Honshu, sometimes, like the Labrador Current in the Atlantic, bringing with it quantities of Arctic ice. This is often called by its Japanese name of Oyashiwo.

539. On the Pacific coast of North America, from about 50° N. to the mouth of the Gulf of California, 23° N., a cold current, 200 or 300 miles wide, flows with a mean speed of three-quarters of a knot, being generally stronger near the land than at sea. It follows the trend of the land (nearly SSE.) as far as Point Concepcion (south of Monterey), when it begins to bend toward SSW., and then to WSW., off Capes San Blas and San Lucas, ultimately joining the great northern equatorial drift.

On the coast of Mexico, from Cape Corrientes (20° N.) to Cape Blanco (Gulf of Nicoya), there are alternate currents extending over a space of more than 300 miles in width, which appear to be produced by the prevailing winds. During the dry season—January, February, and March—the currents generally set toward southeast; during the rainy season—from May to October—especially in July, August, and September, the currents set to northwest, particularly from Cosas Island and the Gulf of Nicoya to the parallel of 15°.

540. The Southern Equatorial Current prevails between limits of latitude that may be approximately given as 4° N. and 10° S., in a broad region extending from the American continent almost to the one hundred and eightieth meridian, setting always to the west and with slowly increasing velocity. In the neighborhood of the Fiji Islands this current divides; one part, known as the *Rossel Current*, continues to the westward, following a route marked by the various passages between the islands, and later acquiring a northerly component and setting through Torres Strait and along the north coast of New Guinea; the other part, called the *Australia Current*, sets toward south and west, arriving off the east coast of Australia, along which it flows southward to about latitude 35° S., whence it bends toward southeast and east and is soon after lost in the currents due to the prevailing wind.

541. The general drift current that sets to the north out of the Antarctic regions is deflected until, upon gaining the regions to the southwest of Patagonia, it has acquired a nearly easterly set; in striking the shores of the South American continent it is divided into two branches.

The first, known as the *Cape Horn Current*, maintains the general easterly direction, and its influence is felt, where not modified by winds and tidal currents, throughout the vicinity of Cape Horn, and, in the Atlantic Ocean, off the Falkland Islands and eastern Patagonia.

The second branch flows northeast in the direction of Valdivia and Valparaiso, follows generally the direction of the coast lines of Chile and Peru (though at times setting directly toward the shore in such manner as to constitute a great danger to the navigator), and forms the important current which has been called variously the *Peruvian, Chilean,* or *Humboldt Current*, the last name having been given for the distinguished scientist who first noted its existence. The principal characteristic of the Peruvian Current is its relatively low temperature. The direction of the waters between Pisco and Payta is between north and northwest; near Cape Blanco the current leaves the coast of America and bears toward the Galapagos Islands, passing them on both the northern and southern sides; here it sets toward WNW. and west; beyond the meridian of the Galapagos it widens rapidly, and the current is lost in the equatorial current, near 108° W. As often happens in similar cases, the existence of a countercurrent has been proved on different occasions; this sets toward the south, is very irregular, and extends only a little distance from shore.

542. CURRENTS OF THE INDIAN OCEAN.—In this ocean the currents to the north of the equator are very irregular; the periodical winds, the alternating breezes, and the changes of monsoon produce currents of a variable nature, their direction depending upon that of the wind which produces them, upon the form of neighboring coasts, or, at times, upon causes which can not be satisfactorily explained.

543. There is, in the Indian Ocean south of the equator, a regular *Equatorial Current* which, by reason of owing its source to the southeast trade winds, corresponds with the Southern Equatorial Currents of the Atlantic and Pacific. The limits of this west-moving current vary with the longitude as well as with the season. Upon reaching about the meridian of Rodriguez Island, a branch makes off toward the south and west, flowing past Mauritius, then to the south of Madagascar (on the meridian of which it is 480 miles broad), and thereafter, rapidly diminishing its breadth, forming part of the Agulhas Current a little to the south of Port Natal.

The main equatorial current continues westward until passing the north end of Madagascar, where, encountering the obstruction presented by the African continent, it divides, one branch following the coast in a northerly, the other in a southerly direction. The former, in the season of the southwest monsoon, is merged into the general easterly and northeasterly drift that prevails throughout the ocean from the northern limit of the Equatorial Current on the south, as far as India and the adjacent Asiatic shores on the north; but during the northeast monsoon, when there exists in the northern regions of the Indian Ocean a westerly drift current analogous to the Northern Equatorial Currents produced in the Atlantic and Pacific by the northeast trades, there is formed an east-setting *Equatorial Countercurrent*, which occupies a narrow area near the equator and is made up of the waters accumulated at the western continental boundary of the ocean by the drift currents of both hemispheres.

544. The southern branch of the Equatorial Current flows to the south and west down the Mozambique Channel, and, being joined in the neighborhood of Port Natal by the stream which arrives from the open ocean, there is formed the warm *Agulhas Current*, which possesses many of the characteristics of the Gulf and Japan streams. This current skirts the east coast of South Africa and attains considerable velocity over that part between Port Natal and Algoa Bay. During the summer months its effects are felt farther to the westward; during the winter it diminishes in force and extent. The meeting of the Agulhas Current with the cold water of higher latitudes is frequently denoted by a broken and confused sea.

Upon arriving at the southern side of the Agulhas Bank the major part of the current is deflected to the south, and then curves toward east, flowing back into the Indian Ocean with diminished strength and temperature on about the fortieth parallel of south latitude, where its influence is felt as far as the eightieth meridian. A small part of the stream which reaches Agulhas Bank continues across the southern edge of that bank before turning to the southward and eastward to rejoin the major part.

545. Along the fortieth parallel of south latitude, between Africa and Australia, there is a general easterly set, due to the branch of the Agulhas Current already described, to the continuation of the drift current from the Atlantic which passes to southward of the Cape of Good Hope, and to the westerly winds which largely prevail in this region. At Cape Leeuwin, the southwestern extremity of Australia, this east-setting current is divided into two branches; one, going north along the west coast of Australia, blends with the Equatorial Current nearly in the latitude of the Tropic of Capricorn; the other preserves the direction of the original current and has the effect of producing an easterly set along the south coast of Australia.

546. As in the other oceans, a general northerly current is observed to set into the Indian Ocean from the Antarctic regions.

CHAPTER XXII.

ICE AND ITS MOVEMENT IN THE NORTH ATLANTIC OCEAN.

547. Vessels crossing the Atlantic Ocean between Europe and the ports of the United States and British America are liable to encounter icebergs or extensive fields of compact ice, which are carried southward from the Arctic region by the ocean currents. It is in the vicinity of the Great Bank of Newfoundland that these masses of ice appear in the greatest numbers and drift farthest southward. The accompanying charts show the changeable area in which icebergs and field ice have been reported by mariners in the years 1904 to 1913 in the months of April, May, and June, when they occur in the greatest number.

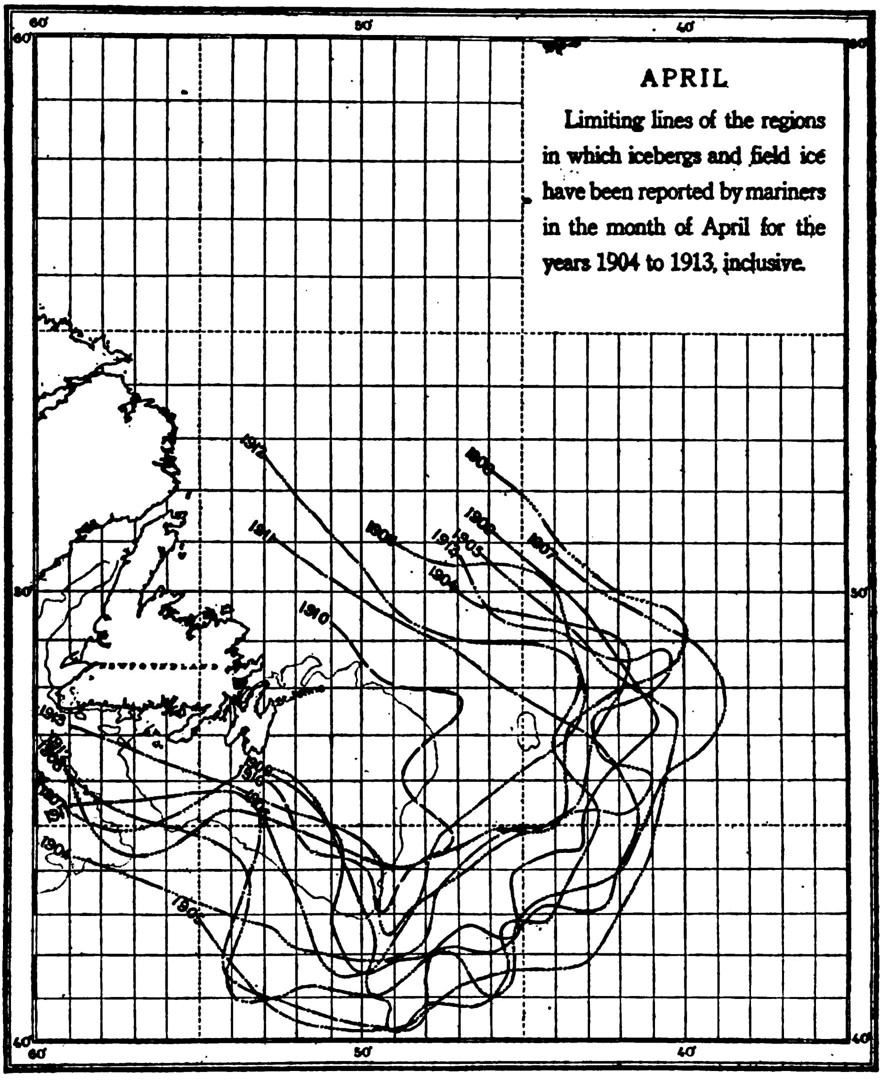

60°
50°
40°
60
50
40
APRIL
Limiting lines of the regions in which icebergs and field ice have been reported by mariners in the month of April for the years 1904 to 1913, inclusive.
1912
1911
1910
1906
1908
1909
1907
1913
1905
1904

FIG. 78.

The amount of ice and its location and movement are so variable from year to year, while the region occupied in its formation and transportation is so vast and so little under special observation, that no successful system of prediction has as yet been instituted. The most that can be said now is that after an exceptionally open winter in the Arctic we may expect the ice to come south earlier and in greater quantity. After such a winter the East Greenland current starts the ice stream around Cape Farewell from one to three months earlier, and this advancing of the season is reflected by a corresponding advance in the Labrador Current and on the Newfoundland Bank. The greatest calving at the glaciers of Greenland follows the breaking up of the shore ice, and hence the bergs also start southward earlier and with more freedom after an open winter.

In April, May, and June, from 1904 to 1913, inclusive, icebergs have been seen as far south as latitude 37° 50′ north and as far east as longitude 38° west. Exceptional drifts have occurred almost down to latitude 30° north, and between longitudes 10° and 75° west, in these months as well as during other seasons of the year. Between Newfoundland and the fortieth parallel floating ice may be met in any month, but not often from August to December. On the Great Bank of Newfoundland bergs generally move southward. Those that drift westward of Cape Race usually pass between Green and St. Pierre banks. The Virgin Rocks are generally surrounded by ice until the middle of April or the beginning of May.

548. **The Origin of the Icebergs.**—Most of the bergs which annually appear in the North Atlantic originate on the western coast of Greenland; a few come from the east coast and from Hudson Bay. A small but productive glacier in southern Greenland yields the bluish bergs which are so hard to see at night. The largest bergs come from the glaciers at Umanak Fjord and Disko Bay (Lat. 69° to 71°), and their height above water will rise to 500 feet; but as they lose in mass from that time forward, we can not expect to find them of such gigantic height when they finally appear near the Newfoundland Bank.

A huge ice sheet, formed from compressed snow, covers the whole of the interior of Greenland. The surface of this enormous glacier, only occasionally interrupted by protruding mountain tops, rises slightly toward the interior and forms a watershed between the east and west coasts, which is estimated to be from 8,000 to 10,000 feet above the sea. The outskirts of Greenland, as they are called, consist of a fringe of islands, mountains, and promontories surrounding the vast ice-covered central portion and varying in width from a mere border up to 80 miles. Upon the west side, below the parallel of 73° of latitude, it has an average width of about 50 miles and extends with little interruption from Cape Farewell to Melville Bay, a distance of something over 1,000 miles.

Everywhere this mountainous belt is penetrated by deep fiords, which reach to the inland ice, and are terminated by the perpendicular fronts of huge glaciers, while in some places the ice comes down in broad projections close to the margin of the sea. All of these glaciers are making their way toward the sea, and, as their ends are forced out into the water, they are broken off and set adrift as bergs. This process is called *calving*. The size of the pieces set adrift varies greatly, but a berg from 60 to 100 feet to the top of its walls, whose spires or pinnacles may reach from 200 to 250 feet in height and whose length may be from 300 to 500 yards, is considered to be of ordinary size in the Arctic. These measurements apply to the part above water, which is about one-eighth or one-ninth of the whole mass. Many authors give the depth under water as being from eight to nine times the height above; this is incorrect, as measurements above and below water should be referred to mass and not to height.

Bergs are being formed all the year round, but in greater numbers during the summer season; and thousands are set adrift each year.

Once adrift in the Arctic they find their way into the Labrador Current and begin their journey to the southward. It is not an unobstructed drift, but one attended with many stoppages and mishaps. Many ground in the Arctic Basin and break up there; others reach the shores of Labrador, where from one end to the other they continually ground and float; some break up and disappear entirely, while others get safely past and reach the Grand Bank. The whole coast of Labrador is cut up by numerous islands, bays, and headlands, shoals and reefs, which makes the journey of all drift a long one, and adds greatly to the destruction of the bergs by stoppages and by causing them to break up. Disintegration is also hastened by their breaking away from the floe ice, for detached bergs will melt and break up rapidly even in high latitudes during the summer.

549. The Ice-Bearing Currents.—The Labrador Current passes to the southward along the coasts of Baffin Land and Labrador, and, although it occasionally ceases altogether, its usual rate is from 10 to 36 miles per day. Near the coast it is very much influenced by the winds, and reaches its maximum rate after those from the northward. The general drift of the current is to the southward, as shown by the passage of many icebergs, although occasions have arisen on which these have been observed to travel northward without any apparent reason. The breadth and depth of the current are not known, but it is certain that it pours into the Atlantic enormous masses of water for which compensation is derived from the warm waters of the Atlantic and from the East Greenland Current that flows around Cape Farewell. The flow of the Polar Current down the east coast of Greenland has been abundantly demonstrated by the drift of vessels that have been beset in the ice pack to the eastward of Greenland. This current turns around Cape Farewell, with an ice stream

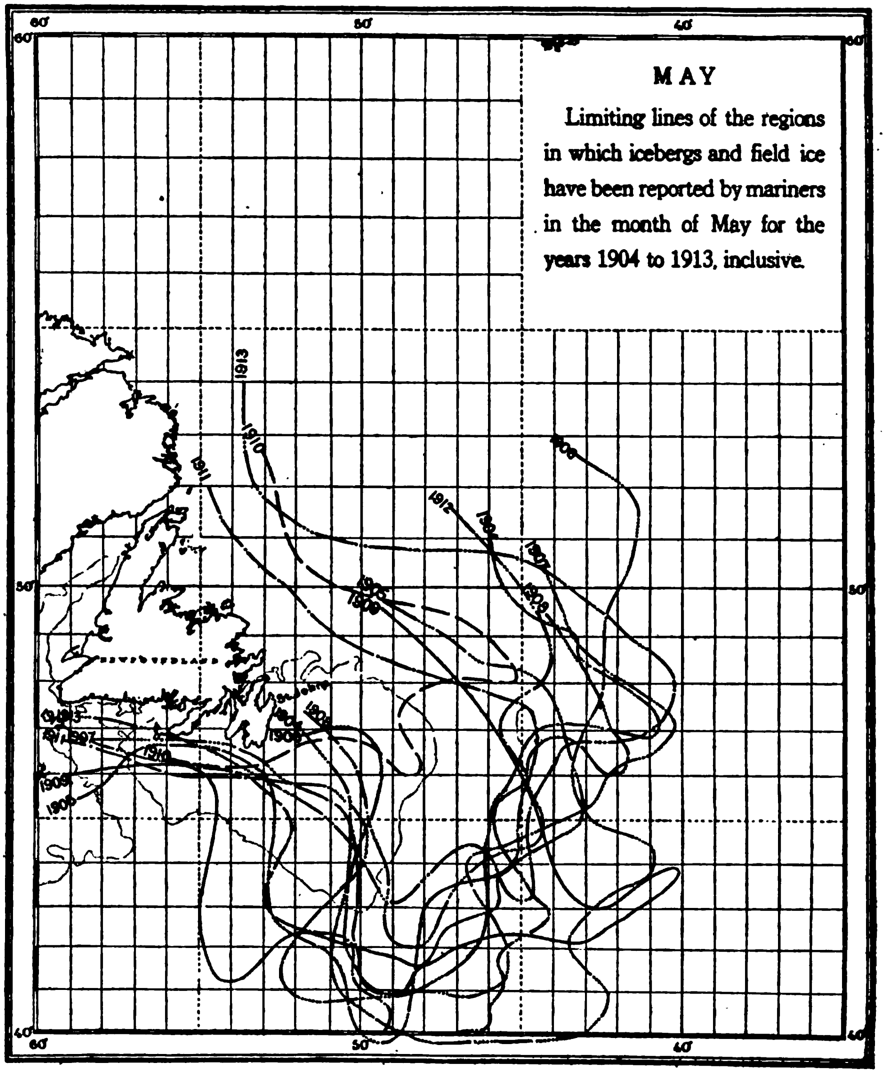

60°
50°
40°
MAY
Limiting lines of the regions in which icebergs and field ice have been reported by mariners in the month of May for the years 1904 to 1913, inclusive.
1913
1910
1911
1912
1907
1908
1909
1905
1906
1904

Fig. 79.

60 miles wide, and then takes a northwesterly direction along the Greenland coast as far as the Arctic Circle, where it meets the southerly current from Baffin Bay.

550. Drift and Characteristics of Icebergs.—Not all the bergs made in any one season find their way south during the following one, for only a small percentage of them ever reach trans-Atlantic routes. So many delays attend their journey and so irregular and erratic is it that many bergs seen in any one season may have been made several seasons before. If bergs on their calving at once drifted to the southward and met with no obstructions their journey of about 1,200 to 1,500 miles would occupy from 4 to 5 months, reckoning the drift of the Labrador Current at 10 miles a day, which may be making it too little. Then, if bergs were liberated principally in July and August they should reach trans-Atlantic routes in December and January, while we know this to be the rare exception. It is then seen what an important bearing the shores of Labrador have in arresting their flow, when it is known that bergs are generally most plentiful in the late spring and early summer months off the Bank.

It should not be supposed that all bergs follow the same course when set adrift from their parent glaciers, for, like floating bodies at the head of a river, some will go direct to the mouth, others will go but a short distance and lodge, others still will accomplish half the journey and remain until another freshet again floats them, so that in the end the débris will be composed in part of that of several years' production.

Bergs, when first liberated on the west Greenland shore, are out of the strongest sweep of the southerly current, and they may take some months to find their way out of Davis Strait, while again others may at once drift into the current and move unobstructed until dissipated in the Gulf Stream. The difference in time of two bergs reaching a low latitude, which were set adrift the same day, may cover a period of one or two years.

Field ice also offers an obstruction to bergs, and a close season in the Arctic may prevent their liberation to a great extent, though, from their deep submersion, they act as ice plows and aid materially in breaking up the vast fields of ice which so often close the Arctic Basin.

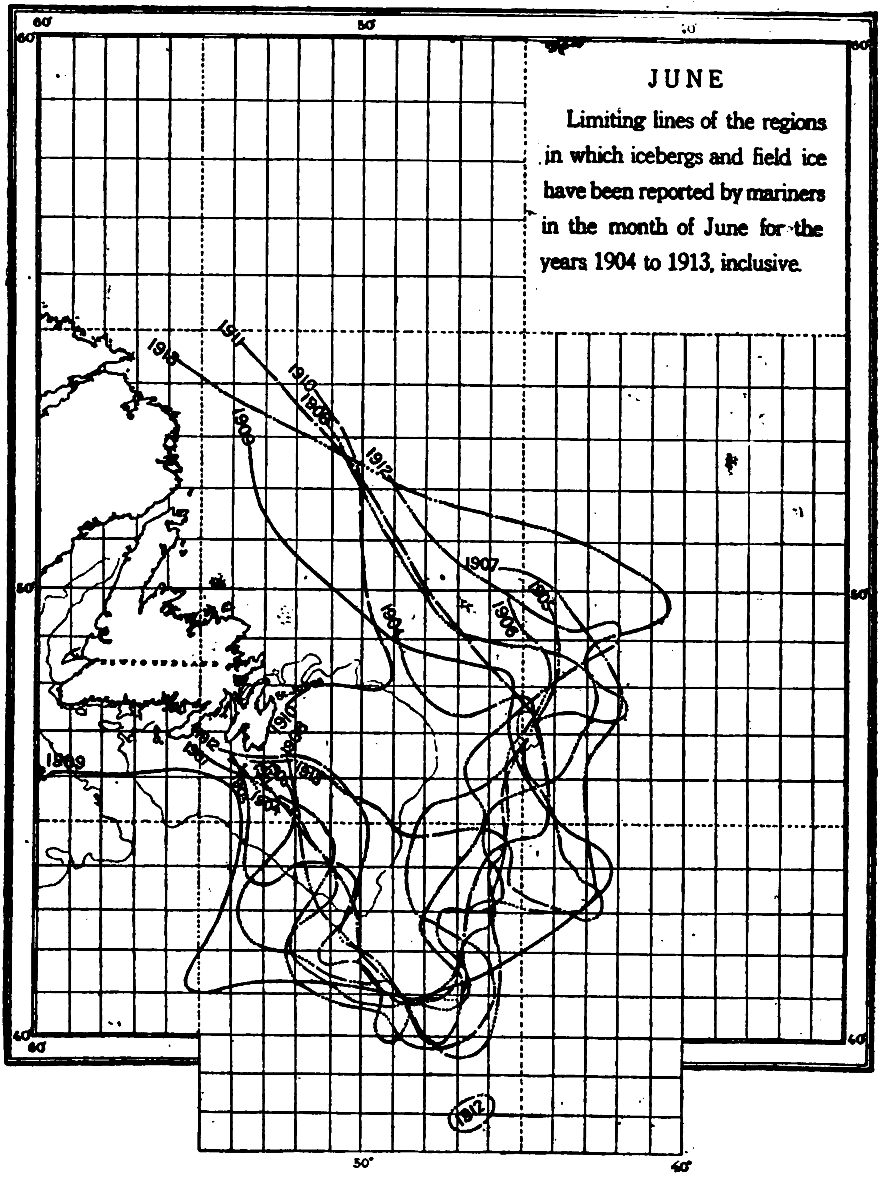
Ice fields are more affected by wind than bergs. Bergs owe their drift almost entirely to current, so that they will often be noticed forcing their way through immense fields of heavy ice and going directly to windward. Advantage is taken of this by vessels in ice fields, which often moor to bergs and are towed for miles through ice in which they could not otherwise make any headway. This is accomplished by sinking an ice anchor into them and using a strong towline, and as the berg advances open water is left to leeward while the loose ice floats past on both sides. For the same reason vessels, when beset by field ice, run from the lee of one berg to that of another, as leads may offer themselves.

Instances are not rare where icebergs were seen to drift toward north, making 15 to 24 miles a day, near the tail of the Bank and to the eastward of Cape Race.

All ice is brittle, especially that in bergs, and it is wonderful how little it takes to accomplish their destruction. A blow of an ax will at times split them, and the report of a gun, by concussion, will accomplish the same end. They are more apt to break up in warm weather than cold, and whalers and sealers note this before landing on them, when an anchor is to be planted or fresh water to be obtained. On the coast of Labrador in July and August, when it is packed with bergs, the noise of rupture is often deafening, and those experienced in ice give them a wide berth.

When they are frozen the temperature is very low, so that when their surface is exposed to a thawing temperature the tension of the exterior and interior is very different, making them not unlike a Prince Rupert's drop. Then, too, during the day water made by melting finds its way into the crevices, freezes, and hence expands, and, acting like a wedge, forces the berg into fragments. It is the greatly increased surface which the fragments expose to the melting action of the oceanic waters that accounts for the rapid disappearance of the ice after it has reached the northern edge of the warm circulatory drift currents of the North Atlantic Ocean. If these processes of disintegration did not go on and large bergs should remain intact, several years might elapse before they would melt, and they would ever be present in the transoceanic routes. In fact, instances are on record in which masses of ice, escaping the influences of swift destruction or possessing a capability for resisting them, have, by phenomenal drifts, passed into European waters and been encountered from time to time throughout that portion of the ocean which stretches from the British Isles to the Azores.

Icebergs assume the greatest variety of shapes, from those approximating to some regular geometric figure to others crowned with spires, domes, minarets, and peaks, while others still are pierced by deep indentations or caves. Small cataracts fall from the large bergs, while from many icicles hang in clusters from every projecting ledge. They frequently have outlying spurs under water, which are as dangerous as any other sunken reefs. For this reason it is advisable for vessels to give them a wide berth, for there are cases on record where vessels were seriously damaged by striking when apparently clear of the berg. Among these is that of the British steamship *Nessmore,* which ran into a berg in latitude 41° 50′ N., longitude 52° W., and stove in her bows. On docking her a long score was found extending from abreast her forerigging all of the way aft, just above her keel. Four frames were


JUNE

Limiting lines of the regions in which icebergs and field ice have been reported by mariners in the month of June for the years 1904 to 1913, inclusive.

Fig 80.

broken and the plates were almost cut through. The ship evidently struck a projecting spur after her helm had been put over, as there was clear water between her and the berg after the first collision.

It is generally best to go to windward of an iceberg, because the disintegrated fragments will have a tendency to drift to leeward while open water will be found to windward. Serious injury has occurred to vessels through the breaking up or capsizing of icebergs. Often the bergs are so nicely balanced that the slightest melting of their surfaces causes a shifting of the center of gravity and a consequent turning over of the mass into a new position, and this overturning also frequently takes place when bergs, drifting with the current in a state of delicate equilibrium, touch the ocean bottom.

551. Field Ice.—Field ice is formed throughout the region from the Arctic Ocean to the shores of Newfoundland and yearly leaves the shore to find its way into the path of commerce. Starting with the Arctic field ice and coming to the southward, we find this ice growing lighter, both in thickness and in quantity, until it disappears entirely. Ice made in the Arctic is heavier and has lived through a number of seasons. After the short summer in high latitudes ice begins to form on all open water, increasing several feet in thickness each season. Much of this remains north during the following summer, and, though it melts to some extent, it never entirely disappears, so that each succeeding winter adds to its thickness.

This continues from year to year until it reaches 12 or 15 feet in thickness, often more. If it remained perfectly quiet it would be of uniform thickness, increasing with the latitude, but it is in a state of almost continual motion, often a very violent one, which causes it to raft and pile until it becomes full of hummocks and other irregularities. Immense fields are detached from the shore and from other fields, and under the influence of winds, currents, and tides are set in motion and kept continually drifting from place to place; after a snow, thaw, or piling the whole becomes cemented together into solid pieces, when under the influence of a low temperature. The space of open water between the fields becomes frozen, joining smaller fields, and making a solid pack which will remain so until the elements again break it to pieces. Along the shores from headland to headland the bays and inlets often remain solid for years, almost invariably through the Arctic winter, but in Baffin Bay and Davis Strait open water can be found at intervals all the year round.

Ice becomes rafted in a variety of ways. If two fields are adrift the one to windward will drift down on the one to leeward; the one which is rougher on its surface gives the wind a better hold and drifts the faster; fields may be impelled towards each other by winds from contrary directions. Ice that is secure to the shore is rafted on its seaward edge from contact with that which is adrift. Fields in drifting often have a turning motion, which is caused by contrary currents, or one variable in strength at different places, or by the friction of a field coming in contact with another field afloat or one attached to the shore. This rotary motion is especially dangerous when a vessel finds itself between two fields. A heavy gale will break up the strongest fields at times and cause them to raft and form hummocks.

Small fragments of bergs find themselves mingled with Arctic fields and become frozen fast. These, when liberated to the southward, are called *growlers*, and form low, dark, indigo colored masses, which are just awash and rounded on top like a whale's back. They are very dangerous when in ice fields which have become loose enough to permit the passage of vessels through them, and should always be looked for; they can be seen apparently rising and sinking as the sea breaks over them.

During the spring and summer months the bergs, aided by a rise of temperature, so cut up and weaken the ice fields that much ice is loosened and begins drifting out of the Arctic basin. This is joined by that brought from the waters of Spitzbergen by the East Greenland Current, near the sixty-third parallel, whence it flows down the eastern coast of North America, reaching Cape Chidley about October or November. By this time the remaining ice in the Arctic is being cemented into solid fields, while the ice cap is being daily extended to the southward. As fast as fields are detached the open water freezes, and these masses are forced to the southward and can not rejoin the solid pack. With a westerly wind ice formed in Hudson Strait and adjacent waters is swept out and joins the Arctic ice, differing from it only in being a little lighter.

Ice begins to form at Cape Chidley about the middle of October, at Belle Isle about November 1, and by the middle of November or 1st of December, the whole coast is solidly frozen. The dates given are approximate and vary from year to year, with many marked exceptions.

The string of ice along the coast of Labrador extends from headland to headland, including the outlying islands, and starting from the heads of the bays works its way out to seaward, forming by the middle of December an impassable barrier to the shore which will probably not be permanently broken until the latter part of April. This ice varies in thickness from 12 feet at the northern extreme to 3 or 4 feet at the southern. During the entire winter the Arctic drift is finding its way down the coast, and is being continually reinforced by fields broken from the Labrador ice. These continue to the southward in the Labrador Current on an average of about 10 miles a day, reaching Belle Isle between the middle of January and the middle of February.

The best example on record of a continued drift from the Arctic is that of Captain Tyson. On October 14, 1871, he and a party of nineteen others were separated from the United States surveying ship *Polaris*, in latitude 77° or 78° N., just south of Littleton Island, and, being unable to regain the ship, remained on the floe and accomplished one of the most wonderful journeys. After a drift of over 1,500 miles, fraught with danger from beginning to end, they were picked up about six months later, April 30, 1872, by the *Tigress*, a sealing steamer from Newfoundland, near the Strait of Belleisle, in latitude 53° 35′ N., and carried safely into port.

Much delay in the southward movement of the drift will be caused by winds from the southward of west, as field ice is affected more by wind than current. The prevailing wind and weather will influence the drift very greatly. Strong northerly or northwest winds will increase its speed, but contrary winds will hold it back. The string of shore ice keeps the northern ice off the coast and in the current. At times westerly winds will also send the Labrador ice off the coast and leave it entirely clear, but this does not happen often. Still the outer Labrador ice is constantly being added to the Arctic flow. Frequently the bays remain frozen over until June; again, they are cleared some years in April, making a large variation. During the drift the wind from northwest to southwest will clear the ice off the coast and leave a line of open water, but the ice will be set on the coast by a northeast wind and be rafted and piled. The appearance of the ice when it reaches Belle Isle and to the southward would be a fair indication of the weather it had encountered on its way down. The rougher the ice the more severe the weather. This floating ice string extends approximately 200 miles offshore in the latitude of Cape Harrison, and spreads more during its drift, though narrower farther north. One small stream finds its way through the Strait of Belleisle, while the greater part continues toward the northern limit of the Gulf Stream. By the middle of January the shores of Newfoundland and Gulf of St. Lawrence are full of ice, which has been frozen there and are opened or closed by a favorable or adverse wind. Navigation in the River St. Lawrence is closed about the middle of November and does not open until about May. A wind from northwest to southwest will clear the eastern coast of Newfoundland, while the Gulf of St. Lawrence may remain full of ice until the 1st of May. Even after this date much ice is found in the Gulf until July, and by August or earlier the field ice is replaced in the Strait of Belleisle by bergs.

In the bight from Cape Bauld to Fogo Island a string of ice is often found joining these points, hemming in the shore for weeks at a time.

With each northwest or westerly wind the ice is cleared off the Newfoundland coast, except from some of the deeper bays, and carried out to sea, and frequently before the Arctic and Labrador ice has passed Belle Isle the Newfoundland ice has found its way as far south as latitude 45°. In the same way the Labrador ice sometimes precedes the Arctic ice, while all may arrive at nearly the same time. Ice fields often lose their identity, as coming from any one particular place, by the constant intermingling on its southern journey with ice made in a lower latitude.

With easterly winds the field ice and icebergs may block the harbors on the east coast of Newfoundland until June or even July, but these harbors are usually open in May.

Ice leaving the gulf and river St. Lawrence flows southward through Cabot Strait. This strait is never frozen over completely, but vessels not specially built to encounter ice can not navigate it safely between the beginning of January and the last of April on account of the heavy drift ice which blocks the passage. Nearly every spring, from about the middle of April to the middle of May, a great rush of ice out of the Gulf of St. Lawrence causes a block between St. Paul Island and Cape Ray. This block, which sometimes lasts for three or four weeks, and completely prevents the passage of ships, is known as the *bridge*. It is recorded that 300 vessels have at one time been detained by this obstacle.

The ice usually passes out of Cabot Strait in the direction of Banquereau Bank, with its eastern edge extending halfway between Scatari and St. Pierre Islands. Its path broadens after it is through the strait and is principally governed by the winds, but, under the influence of the current alone, it drifts southwestward, and in latitude 45° may be from 10 to 75 miles in width. Much of this ice is very heavy and prevents the passage through it of all vessels that are not specially built to encounter ice.

Ice fields assume a variety of shapes, depending upon the influence of winds and currents, and upon their shape on being set adrift. Those loosened in the Arctic meet with so many vicissitudes that they have entirely lost their original form when a low latitude is reached, while those from Newfoundland may remain approximately intact. Their extent is governed by the same rules and varies from a few scattered pieces to several hundred miles in length.

From off Belle Isle the field ice finds its way south toward the Gulf Stream, where no definite shape can be given it. In appearance, if heavy ice, it will be white, covered with snow, and visible at a long distance; even in foggy weather it can often be seen for some distance. It is full of hummocks and its surface is very uneven; blocks have been piled upon each other, others stood on end, and the whole mass will form an impenetrable field, through which vessels can not force their way.

If the ice is lighter the pans will be smoother and more even, the angles ground down by friction and turned up at the edges like so many large pond lilies. If compact, no water is seen; if loose, wide leads may extend through the whole, or a little water be seen surrounding each cake.

The appearance must decide whether a vessel is warranted in trying to force her way through. In a smooth sea, where doubt exists, should a vessel go dead slow into the mass, there will be but little danger in attempting it, and if too heavy she can haul out. Often the weather edge is the heaviest from being rafted, when to leeward it may be scattering. An ice field will often form a good lee for riding out a gale of wind, as it will break the force of the sea. But care is necessary not to lie too close, for the pans are often given such a force that they will stave in the bows of the strongest vessel.

A high temperature will soften field ice and make it very rotten, so that the slightest motion will cause it to fall to pieces. On reaching the waters of the Gulf Stream or a warmer atmospheric temperature it begins to melt, gets soft and spongy, and left in a calm will disappear slowly. But, fortunately, there is seldom a time when there is not a swell on the sea, and this soon breaks the pans into small pieces, thus bringing a greater surface in contact with the melting agency. A heavy gale will in a few hours sometimes cause the destruction of a large field by fracture, friction, and continued motion, just as a calm cold night may unite it in a solid mass. Bergs plow their way through fields, break them up, and scatter the pieces, as in the Arctic. Snow preserves them and often gives the pans the appearance of standing well out of water, and is misleading in this particular. By melting and afterwards freezing it adds to the thickness of the ice.

552. The Disappearance of the Ice.—The advancing ice will have reached, in the month of April, the northern average limit of the Gulf Stream; and, having spread itself along this line both east and west of the fiftieth meridian, it enters the final stage of disintegration and rapid disappearance.

After reaching this limit of southward movement, many bergs, on account of their deep immersion, find their way to the westward, even within the current of the Gulf Stream, while field ice never follows this course, a condition that is accounted for by the fact that the Labrador current here runs under the Gulf Stream, which spreads itself out on the surface as an eastward-moving current, consisting of streaks of warm water with colder water between.

The locality in which ice of all kinds is most apt to be found during the months of April, May, and June lies between latitude 42° and 45° and longitude 47° and 52° west of Greenwich. Here the Gulf Stream and the Labrador Current meet, and the movement of the ice is influenced sometimes by the one and sometimes by the other of these currents.

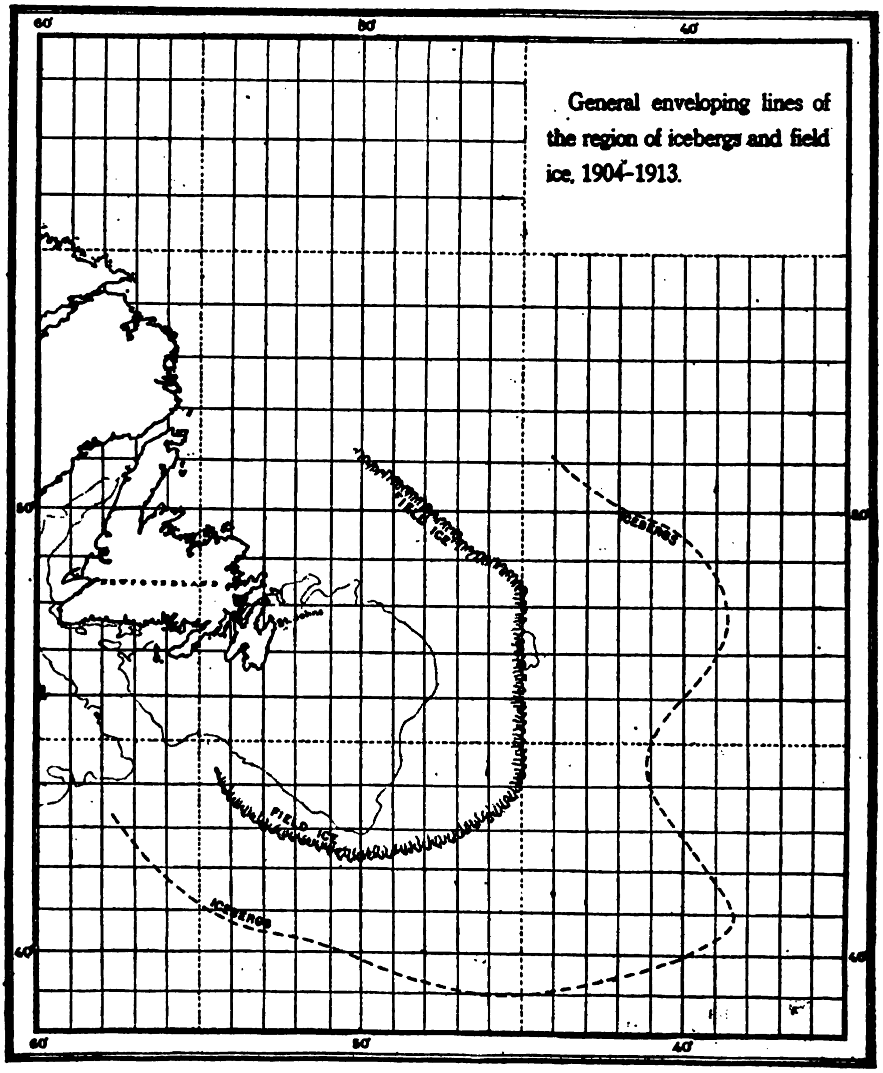

60°
50°
40°
General enveloping lines of the region of icebergs and field ice, 1904-1913.
50°
50°
FIELD ICE
ICEBERGS
FIELD ICE
ICEBERGS
40°
40°
60°
50°
40°

FIG. 81.

Besides the three charts of monthly limits for April, May, and June, a fourth chart is presented showing the general limits within which icebergs and field ice have been encountered during the same months.

553. SIGNS OF THE PROXIMITY OF ICE.—The proximity of ice is indicated by the following-described signs:

Before field ice is seen from deck the ice blink will often indicate its presence. On a clear day over an ice field on the horizon the sky will be much paler or lighter in color and is easily distinguished from that overhead, so that a sharp lookout should be kept and changes in the color of the sky noted.

On a clear day icebergs can be seen at a long distance, owing to their brightness; during foggy weather they are first seen through the fog as a black object. In thick fog the first sight of a berg is apt to be a narrow streak of dark at the water line.

They can sometimes be detected by the echo from the steam whistle or the fog horn. In that case, by noting the time between the blast of a whistle and the reflected sound, the distance of the berg in feet may be approximately found by multiplying by 550. The absence of echo is by no means proof that no bergs are near, for unless there is a fairly vertical wall, no return of the sound waves can be expected.

The presence of icebergs is often made known by the noise of their breaking up and falling to pieces. The cracking of the ice or the falling of pieces into the sea makes a noise like breakers or a distant discharge of guns, which may often be heard a short distance.

The absence of swell or wave motion in a fresh breeze is a sign that there is land or ice on the weather side.

The appearance of herds of seal or flocks of murre far from land is an indication of the proximity of ice.

The temperature of the air falls as ice is approached, especially on the leeward side, but generally only at an inconsiderable distance from it. The fall of the temperature of the sea water has been held to indicate the nearness of ice, but in regions where there is an intermixture of cold and warm currents going on, as at the junction of the Labrador Current and the Gulf Stream, the temperature of the sea has been known to rise as the ice is approached. The special temperature studies made during the ice patrol of 1912 have not settled the question whether icebergs influence the temperature of sea water to a measurable extent at distances of a mile or so.

A reliable sign of icebergs being near is the presence of calf ice. When such pieces occur in a curved line, as they may do, especially in calm weather, the parent berg is on the concave side of the curve.

No ship captain can afford to trust any of the above-named signs to the exclusion of a good lookout.

CURRENT INFORMATION REGARDING ICE CONDITIONS.—The branch hydrographic offices receive daily the latest information regarding ice and other obstructions to navigation, being furnished with the reports of passing vessels and the ice-patrol ships, as long as such are in service. They also distribute the publications of the Hydrographic Office dealing with this topic, namely, the Hydrographic Bulletin (weekly) and the Pilot Chart (monthly), as well as the pamphlet on North Atlantic Ice Patrols (Reprint No. 24).

APPENDIX I.

EXTRACTS FROM THE AMERICAN NAUTICAL ALMANAC, FOR THE YEAR 1916, WHICH HAVE REFERENCE TO THE EXAMPLES FOR THAT YEAR GIVEN IN THIS WORK.

G. M. T.	Sun's Declination.	Equation of Time.	Sun's Declination.	Equation of Time.	Sun's Declination.	Equation of Time.	Sun's Declination.	Equation of Time.
	° ′	m s	° ′	m s	° ′	m s	° ′	m s
	SUN, JANUARY, 1916.							
	Thursday 20.		Monday 24.		Friday 28.			
0	−20 20.8	−10 51.7	−19 27.4	−11 58.7	−18 28.2	−12 53.5		
2	20 19.7	10 53.2	19 26.2	12 0.0	18 26.9	12 54.5		
4	20 18.7	10 54.7	19 25.0	12 1.2	18 25.6	12 55.5		
6	20 17.6	10 56.2	19 23.9	12 2.5	18 24.3	12 56.5	SEMIDIAMETER.	
8	20 16.5	10 57.7	19 22.7	12 3.7	18 23.0	12 57.4		
10	20 15.5	10 59.2	19 21.5	12 5.0	18 21.7	12 58.4		′
12	20 14.4	11 0.7	19 20.3	12 6.2	18 20.4	12 59.4	Jan. 1	16.30
14	20 13.3	11 2.2	19 19.1	12 7.4	18 19.1	13 0.4	11	16.30
							21	16.28
16	20 12.3	11 3.7	19 17.9	12 8.7	18 17.8	13 1.3	31	16.26
18	20 11.2	11 5.2	19 16.7	12 9.9	18 16.5	13 2.3		
20	20 10.1	11 6.6	19 15.5	12 11.1	18 15.1	13 3.3		
22	−20 9.1	−11 8.1	−19 14.3	−12 12.4	−18 13.8	−13 4.2		
H. D.	0.5	0.7	0.6	0.6	0.7	0.5		
	SUN, APRIL, 1916.							
	Sunday 2.		Sunday 16.		Friday 21.		Tuesday 25.	
0	+ 4 54.5	− 3 41.0	+10 6.3	+ 0 9.4	+11 50.5	+ 1 17.2	+13 10.4	+2 3.3
2	4 56.4	3 39.5	10 8.1	0 10.6	11 52.2	1 18.2	13 12.0	2 4.2
4	4 58.3	3 38.0	10 9.8	0 11.8	11 53.9	1 19.3	13 13.7	2 5.1
6	5 0.3	3 36.5	10 11.6	0 13.0	11 55.6	1 20.3	13 15.3	2 6.0
8	5 2.2	3 35.1	10 13.4	0 14.2	11 57.3	1 21.3	13 16.9	2 6.8
10	5 4.1	3 33.6	10 15.1	0 15.4	11 59.0	1 22.4	13 18.6	2 7.7
12	5 6.0	3 32.1	10 16.9	0 16.6	12 0.7	1 23.4	13 20.2	2 8.6
14	5 7.9	3 30.6	10 18.7	0 17.8	12 2.4	1 24.4	13 21.8	2 9.5
16	5 9.8	3 29.1	10 20.4	0 19.0	12 4.1	1 25.4	13 23.4	2 10.3
18	5 11.8	3 27.6	10 22.2	0 20.2	12 5.8	1 26.4	13 25.1	2 11.2
20	5 13.7	3 26.2	10 24.0	0 21.4	12 7.4	1 27.4	13 26.7	2 12.0
22	5 15.6	3 24.7	+10 25.7	+ 0 22.6	12 9.1	1 28.4	13 28.3	2 12.9
H. D.	1.0	0.7	0.9	0.6	0.8	0.5	0.8	0.4
	Thursday 13.		Monday 17.		Saturday 22.		Wednesday 26.	
0	+ 9 1.7	− 0 35.6	+10 27.5	+ 0 23.8	+12 10.8	+ 1 29.4	+13 29.9	+2 13.7
2	9 3.5	0 34.3	10 29.3	0 25.0	12 12.5	1 30.4	13 31.5	2 14.5
4	9 5.3	0 33.0	10 31.0	0 26.1	12 14.2	1 31.4	13 33.1	2 15.4
6	9 7.2	0 31.7	10 32.8	0 27.3	12 15.9	1 32.4	13 34.7	2 16.2
8	9 9.0	0 30.5	10 34.5	0 28.5	12 17.5	1 33.4	13 36.3	2 17.0
10	9 10.8	0 29.2	10 36.3	0 29.6	12 19.2	1 34.4	13 37.9	2 17.9
12	9 12.6	0 27.9	10 38.0	0 30.8	12 20.9	1 35.4	13 39.5	2 18.7
14	9 14.4	0 26.6	10 39.8	0 32.0	12 22.6	1 36.4	13 41.1	2 19.5
16	9 16.2	0 25.4	10 41.5	0 33.1	12 24.2	1 37.3	13 42.7	2 20.3
18	9 18.0	0 24.1	10 43.3	0 34.3	12 25.9	1 38.3	13 44.3	2 21.1
20	9 19.8	0 22.8	10 45.0	0 35.4	12 27.6	1 39.3	13 45.9	2 21.9
22	9 21.6	0 21.6	10 46.8	0 36.6	12 29.2	1 40.2	13 47.5	2 22.7
H. D.	0.9	0.6	0.9	0.6	0.8	0.5	0.8	0.4

NOTE.—The Equation of Time is to be applied to the G. M. T. in accordance with the sign as given.

G. M. T.	Sun's Declination.	Equation of Time.	Sun's Declination.	Equation of Time.	Sun's Declination.	Equation of Time.	Sun's Declination.	Equation of Time.
	° ′	m s	° ′	m s	° ′	m s	° ′	m s
SUN, APRIL, 1916.								
	Saturday 15.		Wednesday 19.		Sunday 23.			
0	+ 9 44.9	+ 0 5.2	+11 9.4	+ 0 51.3	+12 30.9	+ 1 41.2	SEMIDIAMETER.	
2	9 46.7	0 4.0	11 11.1	0 52.4	12 32.6	1 42.2		
4	9 48.5	0 2.8	11 12.8	0 53.5	12 34.2	1 43.1		
6	9 50.3	0 1.5	11 14.6	0 54.6	12 35.9	1 44.1		
8	9 52.0	− 0 0.3	11 16.3	0 55.7	12 37.5	1 45.0	Apr. 1	16.03
10	9 53.8	+ 0 0.9	11 18.0	0 56.8	12 39.2	1 46.0	11	15.98
12	9 55.6	0 2.1	11 19.7	0 57.9	12 40.8	1 46.9	21	15.94
14	9 57.4	0 3.3	11 21.4	0 59.0	12 42.5	1 47.8	May 1	15.90
16	9 59.2	0 4.5	11 23.1	1 0.1	12 44.1	1 48.8		
18	10 1.0	0 5.8	11 24.9	1 1.2	12 45.8	1 49.7		
20	10 2.7	0 7.0	11 26.6	1 2.2	12 47.4	1 50.6		
22	10 4.5	0 8.2	11 28.3	1 3.3	12 49.1	1 51.6		
H. D.	0.9	0.6	0.9	0.5	0.8	0.5		
SUN, MAY, 1916.								
	Sunday 14.		Monday 15.		Wednesday 17.		Sunday 21.	
0	+18 37.0	+3 47.5	+18 51.4	+3 47.5	+19 19.1	+3 45.7	+20 10.6	+3 35.6
2	18 38.2	3 47.5	18 52.5	3 47.4	19 20.2	3 45.6	20 11.6	3 35.2
4	18 39.4	3 47.5	18 53.7	3 47.4	19 21.3	3 45.5		
6	18 40.6	3 47.5	18 54.9	3 47.3	19 22.4	3 45.3		
8	18 41.8	3 47.5	18 56.1	3 47.3	19 23.6	3 45.2	SEMIDIAMETER.	
10	18 43.0	3 47.5	18 57.2	3 47.2	19 24.7	3 45.0		
12	18 44.2	3 47.5	18 58.4	3 47.2	19 25.8	3 44.9		
14	18 45.4	3 47.5	18 59.6	3 47.1	19 26.9	3 44.8		
16	18 46.6	3 47.5	19 0.7	3 47.1	19 28.0	3 44.6	May 1	15.90
18	18 47.8	3 47.5	19 1.9	3 47.0	19 29.1	3 44.5	11	15.86
20	18 49.0	3 47.5	19 3.1	3 47.0	19 30.3	3 44.3	21	15.83
22	18 50.2	3 47.5	19 4.2	3 46.9	19 31.4	3 44.2	31	15.80
H. D.	0.6	0.0	0.6	0.0	0.6	0.1		
SUN, JUNE, 1916.								
	Wednesday 7.		Tuesday 13.		Wednesday 21.		Sunday 25.	
0	+22 45.2	+1 23.2	+23 13.0	+0 12.5	+23 27.1	−1 29.6	+23 24.2	−2 21.2
2	22 45.7	1 22.3	23 13.2	0 11.5	23 27.1	1 30.6	23 24.1	2 22.3
4	22 46.2	1 21.3	23 13.5	0 10.5	23 27.1	1 31.7	23 23.9	2 23.4
6	22 46.6	1 20.4	23 13.8	0 9.4	23 27.1	1 32.8	23 23.8	2 24.4
8	22 47.1	1 19.4	23 14.0	0 8.4	23 27.1	1 33.9	23 23.6	2 25.5
10	22 47.6	1 18.5	23 14.3	0 7.4	23 27.1	1 35.0	23 23.5	2 26.5
12	22 48.0	1 17.6	23 14.6	0 6.4	23 27.1	1 36.0	23 23.3	2 27.6
14	22 48.5	1 16.6	23 14.8	0 5.3	23 27.1	1 37.1	23 23.2	2 28.6
16	22 49.0	1 15.7	23 15.1	0 4.3	23 27.1	1 38.2	23 23.0	2 29.7
18	22 49.4	1 14.7	23 15.4	0 3.3	23 27.1	1 39.3	23 22.9	2 30.8
20	22 49.9	1 13.8	23 15.6	0 2.2	23 27.0	1 40.4	23 22.8	2 31.8
22	22 50.4	1 12.9	23 15.9	0 1.2	23 27.0	1 41.4	23 22.6	2 32.9
H. D.	0.2	0.5	0.1	0.5	0.0	0.5	0.1	0.5
	Monday 19.		Friday 23.		Tuesday 27.			
0	+23 26.0	−1 3.6	+23 26.5	−1 55.5	+23 20.3	−2 46.6	SEMIDIAMETER.	
2	23 26.1	1 4.7	23 26.4	1 56.6	23 20.1	2 47.6		
4	23 26.1	1 5.8	23 26.3	1 57.6	23 19.9	2 48.6		
6	23 26.2	1 6.9	23 26.2	1 58.7	23 19.7	2 49.7		
8	23 26.3	1 8.0	23 26.2	1 59.8	23 19.4	2 50.7	June 1	15.80
10	23 26.3	1 9.0	23 26.1	2 0.8	23 19.2	2 51.8	11	15.78
12	23 26.4	1 10.1	23 26.0	2 1.9	23 19.0	2 52.8	21	15.77
14	23 26.4	1 11.2	23 25.9	2 3.0	23 18.8	2 53.8	July 1	15.76

NOTE.—The Equation of Time is to be applied to the G. M. T. in accordance with the sign as given.

G. M. T.	Sun's Declination.	Equation of Time.	Sun's Declination.	Equation of Time.	Sun's Declination.	Equation of Time.	Sun's Declination.	Equation of Time.
h	° ′	m s	° ′	m s	° ′	m s	° ′	m s
SUN, JULY, 1916.								
	Wednesday 12.		Monday 24.		Friday 28.			
0	+21 59.6	−5 23.5	+19 53.9	−6 18.1	+19 0.9	−6 18.8		
2	21 58.9	5 24.1	19 52.8	6 18.2	18 59.8	6 18.7		
4	21 58.2	5 24.7	19 51.7	6 18.3	18 58.6	6 18.6		
6	21 57.5	5 25.3	19 50.7	6 18.4	18 57.4	6 18.5		
8	21 56.8	5 25.9	19 49.6	6 18.5	18 56.3	6 18.4		
10	21 56.1	5 26.5	19 48.6	6 18.5	18 55.1	6 18.3		
12	21 55.4	5 27.1	19 47.5	6 18.6	18 53.9	6 18.2		
14	21 54.7	5 27.8	19 46.4	6 18.7	18 52.8	6 18.1		
16	21 54.0	5 28.4	19 45.4	6 18.8	18 51.6	6 18.0		
18	21 53.3	5 29.0	19 44.3	6 18.9	18 50.4	6 17.9		
20	21 52.6	5 29.6	19 43.2	6 19.0	18 49.2	6 17.8		
22	+21 51.9	−5 30.2	+19 42.2	−6 19.1	+18 48.1	−6 17.6		
H. D.	0.4	0.3	0.5	0.0	0.6	0.1		
SUN, OCTOBER, 1916.								
	Sunday 1.		Thursday 5.		Monday 9.		Friday 13.	
0	−3 9.8	+10 16.1	−4 42.7	+11 30.4	−6 14.6	+12 39.1	−7 45.2	+13 40.8
2	3 11.7	10 17.7	4 44.6	11 31.9	6 16.5	12 40.5		
4	3 13.7	10 19.3	4 46.5	11 33.4	6 18.4	12 41.9		
6	3 15.6	10 20.9	4 48.4	11 34.9	6 20.3	12 43.2		
8	3 17.5	10 22.5	4 50.4	11 36.4	6 22.2	12 44.6		
10	3 19.5	10 24.0	4 52.3	11 37.9	6 24.1	12 45.9		
12	3 21.4	10 25.6	4 54.2	11 39.3	6 26.0	12 47.3		
14	3 23.4	10 27.2	4 56.1	11 40.8	6 27.9	12 48.6		
16	3 25.3	10 28.8	4 58.1	11 42.3	6 29.8	12 49.9		
18	3 27.2	10 30.4	5 0.0	11 43.8	6 31.7	12 51.3		
20	3 29.2	10 32.0	5 1.9	11 45.2	6 33.6	12 52.6		
22	3 31.1	10 33.5	5 3.8	11 46.7	6 35.5	12 53.9		
H. D.	1.0	0.8	1.0	0.7	0.9	0.7		

SEMIDIAMETER. (July)

	′
July 1	15.76
11	15.76
21	15.77
31	15.79

SEMIDIAMETER. (October)

	′
Oct. 1	16.01
11	16.06
21	16.10
31	16.15

NOTE.—The Equation of Time is to be applied to the G. M. T. in accordance with the sign as given.

SUN, 1916.

Day of Month.	Right Ascension of the Mean Sun at Greenwich Mean Noon.					
	January.	February.	March.	April.	May.	June.
	h m s	h m s	h m s	h m s	h m s	h m s
1	18 39 16.2	20 41 29.5	22 35 49.6	0 38 2.7	2 36 19.4	4 38 32.6
2	18 43 12.8	20 45 26.0	22 39 46.1	0 41 59.3	2 40 15.9	4 42 29.2
3	18 47 9.3	20 49 22.6	22 43 42.7	0 45 55.8	2 44 12.5	4 46 25.7
4	18 51 5.9	20 53 19.2	22 47 39.2	0 49 52.4	2 48 9.0	4 50 22.3
5	18 55 2.4	20 57 15.7	22 51 35.8	0 53 49.0	2 52 5.6	4 54 18.8
6	18 58 59.0	21 1 12.3	22 55 32.3	0 57 45.5	2 56 2.1	4 58 15.4
7	19 2 55.5	21 5 8.8	22 59 28.9	1 1 42.0	2 59 58.7	5 2 12.0
8	19 6 52.1	21 9 5.4	23 3 25.4	1 5 38.6	3 3 55.2	5 6 8.5
9	19 10 48.7	21 13 1.9	23 7 22.0	1 9 35.2	3 7 51.8	5 10 5.1
10	19 14 45.2	21 16 58.5	23 11 18.6	1 13 31.7	3 11 48.4	5 14 1.6
11	19 18 41.8	21 20 55.0	23 15 15.1	1 17 28.3	3 15 44.9	5 17 58.2
12	19 22 38.3	21 24 51.6	23 19 11.7	1 21 24.8	3 19 41.5	5 21 54.8
13	19 26 34.9	21 28 48.2	23 23 8.2	1 25 21.4	3 23 38.0	5 25 51.3
14	19 30 31.4	21 32 44.7	23 27 4.8	1 29 17.9	3 27 34.6	5 29 47.9
15	19 34 28.0	21 36 41.3	23 31 1.3	1 33 14.5	3 31 31.2	5 33 44.4
16	19 38 24.6	21 40 37.8	23 34 57.9	1 37 11.0	3 35 27.7	5 37 41.0
17	19 42 21.1	21 44 34.4	23 38 54.4	1 41 7.6	3 39 24.3	5 41 37.6
18	19 46 17.7	21 48 30.9	23 42 51.0	1 45 4.2	3 43 20.8	5 45 34.1
19	19 50 14.2	21 52 27.5	23 46 47.5	1 49 0.7	3 47 17.4	5 49 30.7
20	19 54 10.8	21 56 24.0	23 50 44.1	1 52 57.3	3 51 13.9	5 53 27.2
21	19 58 7.4	22 0 20.6	23 54 40.6	1 56 53.8	3 55 10.5	5 57 23.8
22	20 2 3.9	22 4 17.1	23 58 37.2	2 0 50.4	3 59 7.0	6 1 20.3
23	20 6 0.5	22 8 13.7	0 2 33.8	2 4 46.9	4 3 3.6	6 5 16.9
24	20 9 57.0	22 12 10.2	0 6 30.3	2 8 43.5	4 7 0.2	6 9 13.5
25	20 13 53.6	22 16 6.8	0 10 26.9	2 12 40.0	4 10 56.7	6 13 10.0
26	20 17 50.1	22 20 3.4	0 14 23.4	2 16 36.6	4 14 53.3	6 17 6.6
27	20 21 46.7	22 23 59.9	0 18 20.0	2 20 33.1	4 18 49.8	6 21 3.1
28	20 25 43.2	22 27 56.5	0 22 16.5	2 24 29.7	4 22 46.4	6 24 59.7
29	20 29 39.8	22 31 53.0	0 26 13.1	2 28 26.2	4 26 43.0	6 28 56.2
30	20 33 36.4	22 35 49.6	0 30 9.6	2 32 22.8	4 30 39.5	6 32 52.8
31	20 37 32.9	22 39 46.1	0 34 6.2	2 36 19.4	4 34 36.1	6 36 49.4

CORRECTION TO BE ADDED TO R. A. M. S. AT G. M. N. FOR TIME PAST NOON.

Time.	0^{m}	6^{m}	12^{m}	18^{m}	24^{m}	30^{m}	36^{m}	42^{m}	48^{m}	54^{m}	60^{m}	Time.
h	m s	m s	m s	m s	m s	m s	m s	m s	m s	m s	m s	h
0	0 0.0	0 1.0	0 2.0	0 3.0	0 3.9	0 4.9	0 5.9	0 6.9	0 7.9	0 8.9	0 9.9	0
1	0 9.9	0 10.8	0 11.8	0 12.8	0 13.8	0 14.8	0 15.8	0 16.8	0 17.7	0 18.7	0 19.7	1
2	0 19.7	0 20.7	0 21.7	0 22.7	0 23.7	0 24.6	0 25.6	0 26.6	0 27.6	0 28.6	0 29.6	2
3	0 29.6	0 30.6	0 31.5	0 32.5	0 33.5	0 34.5	0 35.5	0 36.5	0 37.5	0 38.4	0 39.4	3
4	0 39.4	0 40.4	0 41.4	0 42.4	0 43.4	0 44.4	0 45.3	0 46.3	0 47.3	0 48.3	0 49.3	4
5	0 49.3	0 50.3	0 51.3	0 52.2	0 53.2	0 54.2	0 55.2	0 56.2	0 57.2	0 58.2	0 59.1	5
6	0 59.1	1 0.1	1 1.1	1 2.1	1 3.1	1 4.1	1 5.1	1 6.0	1 7.0	1 8.0	1 9.0	6
7	1 9.0	1 10.0	1 11.0	1 12.0	1 12.9	1 13.9	1 14.9	1 15.9	1 16.9	1 17.9	1 18.9	7
8	1 18.9	1 19.8	1 20.8	1 21.8	1 22.8	1 23.8	1 24.8	1 25.7	1 26.7	1 27.7	1 28.7	8
9	1 28.7	1 29.7	1 30.7	1 31.7	1 32.7	1 33.6	1 34.6	1 35.6	1 36.6	1 37.6	1 38.6	9
10	1 38.6	1 39.6	1 40.5	1 41.5	1 42.5	1 43.5	1 44.5	1 45.5	1 46.5	1 47.4	1 48.4	10
11	1 48.4	1 49.4	1 50.4	1 51.4	1 52.4	1 53.3	1 54.3	1 55.3	1 56.3	1 57.3	1 58.3	11

SUN, 1916.

Day of Month.	Right Ascension of the Mean Sun at Greenwich Mean Noon.					
	July.	August.	September.	October.	November.	December.
	h m s	h m s	h m s	h m s	h m s	h m s
1	6 36 49.4	8 39 2.6	10 41 15.8	12 39 32.4	14 41 45.6	16 40 2.3
2	6 40 45.9	8 42 59.2	10 45 12.4	12 43 29.0	14 45 42.2	16 43 58.9
3	6 44 42.5	8 46 55.8	10 49 9.0	12 47 25.6	14 49 38.7	16 47 55.4
4	6 48 39.0	8 50 52.3	10 53 5.5	12 51 22.1	14 53 35.3	16 51 52.0
5	6 52 35.6	8 54 48.9	10 57 2.1	12 55 18.7	14 57 31.8	16 55 48.6
6	6 56 32.2	8 58 45.4	11 0 58.6	12 59 15.2	15 1 28.4	16 59 45.1
7	7 0 28.7	9 2 42.0	11 4 55.2	13 3 11.8	15 5 25.0	17 3 41.7
8	7 4 25.3	9 6 38.5	11 8 51.7	13 7 8.3	15 9 21.5	17 7 38.2
9	7 8 21.8	9 10 35.1	11 12 48.3	13 11 4.9	15 13 18.1	17 11 34.8
10	7 12 18.4	9 14 31.6	11 16 44.8	13 15 1.4	15 17 14.6	17 15 31.4
11	7 16 14.9	9 18 28.2	11 20 41.4	13 18 58.0	15 21 11.2	17 19 27.9
12	7 20 11.5	9 22 24.8	11 24 37.9	13 22 54.5	15 25 7.7	17 23 24.5
13	7 24 8.1	9 26 21.3	11 28 34.5	13 26 51.1	15 29 4.3	17 27 21.0
14	7 28 4.6	9 30 17.9	11 32 31.0	13 30 47.6	15 33 0.8	17 31 17.6
15	7 32 1.2	9 34 14.4	11 36 27.6	13 34 44.2	15 36 57.4	17 35 14.1
16	7 35 57.7	9 38 11.0	11 40 24.2	13 38 40.8	15 40 54.0	17 39 10.7
17	7 39 54.3	9 42 7.5	11 44 20.7	13 42 37.3	15 44 50.5	17 43 7.3
18	7 43 50.8	9 46 4.1	11 48 17.3	13 46 33.9	15 48 47.1	17 47 3.8
19	7 47 47.4	9 50 0.6	11 52 13.8	13 50 30.4	15 52 43.6	17 51 0.4
20	7 51 44.0	9 53 57.2	11 56 10.4	13 54 27.0	15 56 40.2	17 54 56.9
21	7 55 40.5	9 57 53.8	12 0 6.9	13 58 23.5	16 0 36.8	17 58 53.5
22	7 59 37.1	10 1 50.3	12 4 3.5	14 2 20.1	16 4 33.3	18 2 50.0
23	8 3 33.6	10 5 46.9	12 8 0.0	14 6 16.6	16 8 29.9	18 6 46.6
24	8 7 30.2	10 9 43.4	12 11 56.6	14 10 13.2	16 12 26.4	18 10 43.2
25	8 11 26.8	10 13 40.0	12 15 53.1	14 14 9.7	16 16 23.0	18 14 39.7
26	8 15 23.3	10 17 36.5	12 19 49.7	14 18 6.3	16 20 19.5	18 18 36.3
27	8 19 19.9	10 21 33.1	12 23 46.2	14 22 2.8	16 24 16.1	18 22 32.8
28	8 23 16.4	10 25 29.6	12 27 42.8	14 25 59.4	16 28 12.6	18 26 29.4
29	8 27 13.0	10 29 26.2	12 31 39.3	14 29 56.0	16 32 9.2	18 30 26.0
30	8 31 9.5	10 33 22.7	12 35 35.9	14 33 52.5	16 36 5.8	18 34 22.5
31	8 35 6.1	10 37 19.3	12 39 32.4	14 37 49.1	16 40 2.3	18 38 19.1

CORRECTION TO BE ADDED TO R. A. M. S. AT G. M. N. FOR TIME PAST NOON.

Time.	0m	6m	12m	18m	24m	30m	36m	42m	48m	54m	60m	Time.
h	m s	m s	m s	m s	m s	m s	m s	m s	m s	m s	m s	h
12	1 58.3	1 59.3	2 0.2	2 1.2	2 2.2	2 3.2	2 4.2	2 5.2	2 6.2	2 7.1	2 8.1	12
13	2 8.1	2 9.1	2 10.1	2 11.1	2 12.1	2 13.1	2 14.0	2 15.0	2 16.0	2 17.0	2 18.0	13
14	2 18.0	2 19.0	2 20.0	2 20.9	2 21.9	2 22.9	2 23.9	2 24.9	2 25.9	2 26.9	2 27.8	14
15	2 27.8	2 28.8	2 29.8	2 30.8	2 31.8	2 32.8	2 33.8	2 34.7	2 35.7	2 36.7	2 37.7	15
16	2 37.7	2 38.7	2 39.7	2 40.7	2 41.6	2 42.6	2 43.6	2 44.6	2 45.6	2 46.6	2 47.6	16
17	2 47.6	2 48.5	2 49.5	2 50.5	2 51.5	2 52.5	2 53.5	2 54.5	2 55.4	2 56.4	2 57.4	17
18	2 57.4	2 58.4	2 59.4	3 0.4	3 1.4	3 2.3	3 3.3	3 4.3	3 5.3	3 6.3	3 7.3	18
19	3 7.3	3 8.3	3 9.2	3 10.2	3 11.2	3 12.2	3 13.2	3 14.2	3 15.2	3 16.1	3 17.1	19
20	3 17.1	3 18.1	3 19.1	3 20.1	3 21.1	3 22.1	3 23.0	3 24.0	3 25.0	3 26.0	3 27.0	20
21	3 27.0	3 28.0	3 29.0	3 29.9	3 30.9	3 31.9	3 32.9	3 33.9	3 34.9	3 35.9	3 36.8	21
22	3 36.8	3 37.8	3 38.8	3 39.8	3 40.8	3 41.8	3 42.8	3 43.7	3 44.7	3 45.7	3 46.7	22
23	3 46.7	3 47.7	3 48.7	3 49.7	3 50.6	3 51.6	3 52.6	3 53.6	3 54.6	3 55.6	3 56.6	23

MOON, 1916.

G. M. T.	Right Ascension.		Declination.		S. D.	H. P.	G. M. T.	Right Ascension.		Declination.		S. D.	H. P.
	April 15.							May 6.					
h	h m s		° ′		′	′	h	h m s		° ′		′	′
0	11 20 23	235	+ 0 19.2	294	15.5	56.9	0	6 15 36	262	+25 48.6	64	14.8	54.2
2	11 24 18	236	− 0 10.2	296	15.6	57.0	2	6 19 58	261	25 42.2	70	14.8	54.2
4	11 28 14	236	0 39.8	295	15.6	57.1	4	6 24 19	261	25 35.2	74	14.8	54.2
6	11 32 10	237	1 9.3	296	15.6	57.1	6	6 28 40	260	25 27.8	78	14.8	54.2
8	11 36 7	238	1 38.9	297	15.6	57.2	8	6 33 0	259	25 20.0	84	14.8	54.2
10	11 40 5	238	2 8.6	297	15.6	57.3	10	6 37 19	259	25 11.6	88	14.8	54.1
12	11 44 3	239	2 38.3	297	15.6	57.3	12	6 41 38	258	25 2.8	93	14.8	54.1
14	11 48 2	240	3 8.0	297	15.7	57.4	14	6 45 56	257	24 53.5	97	14.8	54.1
16	11 52 2	241	3 37.7	298	15.7	57.5	16	6 50 13	257	24 43.8	102	14.8	54.1
18	11 56 3	242	4 7.5	297	15.7	57.5	18	6 54 30	255	24 33.6	107	14.8	54.1
20	12 0 5	242	4 37.2	297	15.7	57.6	20	6 58 45	255	24 22.9	111	14.8	54.1
22	12 4 7	243	5 6.9	296	15.7	57.6	22	7 3 0	254	24 11.8	115	14.8	54.1
	July 10.							October 10.					
0	14 35 34	285	−20 37.9	199	16.0	58.7	0	0 16 45	255	+ 6 59.3	294	16.0	58.6
2	14 40 19	287	20 57.8	194	16.0	58.8	2	0 21 0	255	7 28.7	293	16.0	58.5
4	14 45 6	289	21 17.2	190	16.1	58.9	4	0 25 15	255	7 58.0	291	16.0	58.5
6	14 49 55	291	21 36.2	186	16.1	58.9	6	0 29 30	255	8 27.1	288	16.0	58.5
8	14 54 46	293	21 54.8	180	16.1	59.0	8	0 33 45	256	8 55.9	286	15.9	58.4
10	14 59 39	296	22 12.8	176	16.1	59.1	10	0 38 1	255	9 24.5	284	15.9	58.4
12	15 4 35	297	22 30.4	170	16.1	59.2	12	0 42 16	257	9 52.9	281	15.9	58.3
14	15 9 32	299	22 47.4	165	16.2	59.2	14	0 46 33	256	10 21 0	279	15.9	58.3
16	15 14 31	302	23 3.9	159	16.2	59.3	16	0 50 49	257	10 48.9	276	15.9	58.2
18	15 19 33	303	23 19.8	154	16.2	59.4	18	0 55 6	257	11 16.5	273	15.9	58.2
20	15 24 36	305	23 35.2	148	16.2	59.5	20	0 59 23	258	11 43.8	270	15.9	58.1
22	15 29 41	307	23 50.0	142	16.2	59.5	22	1 3 41	258	12 10.8	268	15.9	58.1
24	15 34 48		−24 4.2		16.3	59.6	24	1 7 59		+12 37.6		15.8	58.0

TIME OF TRANSIT, MERIDIAN OF GREENWICH.

	h m			h m			h m			h m	
Feb. 16	10 37	46	May 20	15 29	59	June 18	15 12	53	July 10	7 40	60
17	11 23		21	16 28	53	19	16 5	48	11	8 40	
Apr. 14	9 21	44	22	17 21	49	20	16 53	47	18	15 33	47
15	10 5		23	18 10		21	17 40	45	19	16 20	

JUPITER, 1916.

GREENWICH MEAN TIME.

Date.	Apparent Right Ascension.		Apparent Declination.		Transit, Meridian of Greenwich.	Date.	Apparent Right Ascension.		Apparent Declination.		Transit, Meridian of Greenwich.
	Noon.		*Noon.*				*Noon.*		*Noon.*		
	h m s		° ′		h m		h m s		° ′		h m
Apr. 15	0 56 28	54	+ 4 51.5	55	23 20	Sept. 15	2 11 38	16	+11 41.1	16	14 33
16	0 57 22	53	4 57.0	56	23 17	16	2 11 22	17	11 39.5	16	14 28
July 25	2 8 20	22	+11 35.9	17	17 54	17	2 11 5	17	11 37.9	17	14 24
26	2 8 42	22	+11 37.6	16	17 51	18	2 10 48	18	11 36.2	17	14 20

Polar Semidiameter: July 1, 0′.30; Aug. 1, 0′ .33; Sept. 1, 0′.36; Oct. 1, 0′.39; Nov. 1, 0′.39; Dec. 1, 0′.37; Dec. 32, 0′.34.
Hor. Parallax: Apr. 1, 0′.26; May 1, 0′.27; July 1, 0′.03; Aug. 1, 0′.03; Sept. 1, 0′.03; Oct. 1, 0′.04; Nov. 1, 0′.04; Dec. 1, 0′.04; Dec. 32, 0′.03.

VENUS, 1916.

GREENWICH MEAN TIME.

Apr 16	4 38 4	267	+25 14.7	110	3 1	June 1	7 17 48	90	+24 48.5	93	2 39

Semidiameter: Jan. 1, 0′.10; Feb. 1, 0′.11; Mar. 1, 0′.13; Apr. 1, 0′.16; May 1, 0′.22; June 1; 0′.34; July 1, 0′.49.
Hor. Parallax: Jan. 1, 0′.10; Feb. 1, 0′.11; Mar. 1, 0′.13; Apr. 1, 0′.16; May 1, 0′.22; June 1, 0′.35; July 1, 0′.50.

APPARENT PLACES OF STARS, 1916.

FOR THE UPPER TRANSIT AT GREENWICH.

No.	Constellation Name.	Right Ascension.														No.	Declination.														Special Name.	Mag.
			Jan. 1.	Feb. 1.	Mar. 1.	Apr. 1.	May 1.	June 1.	July 1.	Aug. 1.	Sept. 1.	Oct. 1.	Nov. 1.	Dec. 1.	Dec. 32.			Jan. 1.	Feb. 1.	Mar. 1.	Apr. 1.	May 1.	June 1.	July 1.	Aug. 1.	Sept. 1.	Oct. 1.	Nov. 1.	Dec. 1.	Dec. 32.		
		h m	s	s	s	s	s	s	s	s	s	s	s	s	s		°	′	′	′	′	′	′	′	′	′	′	′	′	′		
1	α Androm.	0 4	3.0	2.6	2.4	2.5	3.1	4.0	5.1	6.1	6.7	7.0	7.0	6.7	6.3	1	+28	37.8	37.8	37.7	37.6	37.6	37.6	37.7	37.8	38.0	38.1	38.2	38.2	38.2	Alpheratz	2.2
2	β Cassiop.	0 4	41.1	40.2	39.9	39.8	40.7	42.1	43.7	45.1	46.1	46.5	46.3	45.7	44.8	2	+58	41.6	41.5	41.4	41.2	41.1	41.1	41.2	41.3	41.5	41.6	41.8	41.9	41.9	Caph	2.4
3	β Ceti	0 39	23.4	23.0	22.8	22.8	23.2	23.9	24.9	25.9	26.6	27.0	27.0	26.8	26.5	3	−18	26.9	26.9	26.9	26.8	26.7	26.6	26.4	26.4	26.3	26.4	26.4	26.5	26.5	Deneb Kaitos	2.2
4	δ Cassiop.	1 20	19.5	18.5	17.8	17.4	17.9	19.1	20.7	22.3	23.6	24.6	24.9	24.6	23.9	4	+59	48.3	48.3	48.2	48.8	48.0	47.9	17.9	48.0	48.2	48.3	48.5	48.6	48.7	Ruchbah	2.8
5	α Urs. Min.	1 28	111.0	79.0	52.7	38.6	44.5	67.5	99.0	133.4	163.2	182.2	186.8	175.0	149.0	5	+88	51.9	51.9	51.8	51.7	51.5	51.4	51.4	51.4	51.5	51.7	51.9	52.1	52.2	Polaris	2.1
6	α Eridani	1 34	37.0	35.9	35.2	34.7	34.7	35.6	36.8	38.2	39.5	40.3	40.4	40.0	39.1	6	−57	40.0	40.0	39.9	39.7	39.5	39.4	39.2	39.2	39.2	39.3	39.5	39.6	39.7	Achernar	0.6
7	α Arietis	2 2	27.4	27.0	26.6	26.3	26.5	27.2	28.1	29.1	30.1	30.7	31.1	31.2	31.0	7	+23	4.2	4.1	4.1	4.1	4.0	4.1	4.1	4.2	4.3	4.4	4.4	4.5	4.5	Hamal	2.2
8	θ Eridani	2 55	6.5	5.9	5.3	4.7	4.5	4.9	5.7	6.7	7.8	8.6	9.1	9.1	8.8	8	−40	38.5	38.6	38.5	38.5	38.3	38.2	38.0	37.9	37.9	37.9	38.0	38.2	38.3	Acamar	3.0
9	α Persei	3 18	21.3	20.8	20.1	19.5	19.3	19.9	21.0	22.2	23.6	24.8	25.6	26.0	25.9	9	+49	34.1	34.1	34.1	34.0	33.9	33.9	33.8	33.9	33.9	34.0	34.1	34.2	34.3		1.9
10	α Tauri	4 31	8.0	7.9	7.4	6.9	6.7	6.9	7.4	8.3	9.3	10.2	10.9	11.5	11.7	10	+16	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.7	20.7	20.7	20.7	20.7	20.7	Aldebaran	1.1
11	α Aurigæ	5 10	31.8	31.7	31.1	30.4	29.9	29.9	30.5	31.6	32.8	34.1	35.3	36.1	36.5	11	+45	55.0	55.1	55.1	55.1	55.0	54.9	54.9	54.8	54.8	54.9	54.9	55.0	55.0	Capella	0.2
12	β Orionis	5 10	32.1	32.0	31.5	31.0	30.7	30.6	31.1	31.7	32.7	33.5	34.3	34.9	35.1	12	− 8	17.8	17.9	17.9	17.9	17.9	17.8	17.7	17.6	17.6	17.6	17.6	17.7	17.8	Rigel	0.3
13	γ Orionis	5 20	39.6	39.6	39.2	38.7	38.4	38.3	38.8	39.5	40.4	41.3	42.1	42.7	43.1	13	+ 6	16.6	16.5	16.5	16.5	16.5	16.5	16.6	16.6	16.7	16.7	16.7	16.6	16.6	Bellatrix	1.7
14	ε Orionis	5 31	59.2	59.1	58.7	58.2	57.8	57.8	58.2	58.8	59.7	60.6	61.4	62.0	62.4	14	− 1	15.2	15.3	15.3	15.3	15.3	15.2	15.2	15.1	15.0	15.0	15.1	15.1	15.2	Alnitam	1.8
15	α Orionis	5 50	39.7	39.7	39.3	38.8	38.4	38.3	38.7	39.3	40.2	41.1	42.0	42.6	43.1	15	+ 7	23.6	23.6	23.6	23.6	23.6	23.6	23.6	23.7	23.7	23.7	23.7	23.6	23.6	Betelgeux	1.0-1.4
16	α Argus	6 22	7.8	7.5	6.7	5.6	4.6	4.1	4.0	4.5	5.5	6.7	7.9	8.8	9.2	16	−52	38.9	39.1	39.2	39.2	39.2	39.0	38.9	38.7	38.6	38.6	38.7	38.8	39.0	Canopus	−0.9
17	α Can. Maj.	6 41	28.8	28.9	28.5	28.0	27.5	27.2	27.3	27.8	28.6	29.5	30.3	31.1	31.6	17	−16	36.0	36.1	36.2	36.2	36.2	36.1	36.0	35.9	35.8	35.8	35.9	36.0	36.1	Sirius	−1.6
18	ε Can. Maj.	6 55	21.6	21.6	21.3	20.7	20.1	19.7	19.7	20.1	20.9	21.8	22.7	23.5	24.1	18	−28	51.4	51.5	51.6	51.6	51.6	51.5	51.4	51.3	51.2	51.2	51.2	51.3	51.5	Adhara	1.6
19	α Can. Min.	7 34	56.5	56.8	56.6	56.2	55.7	55.5	55.5	55.9	56.5	57.3	58.2	59.1	59.7	19	+ 5	26.5	26.4	26.4	26.4	26.4	26.4	26.4	26.5	26.5	26.5	26.4	26.4	26.3	Procyon	0.5
20	β Gemin.	7 40	13.2	13.6	13.5	13.0	12.5	12.2	12.2	12.6	13.4	14.3	15.3	16.3	17.1	20	+28	13.8	13.8	13.8	13.8	13.9	13.8	13.8	13.8	13.7	13.7	13.6	13.6	13.6	Pollux	1.2
21	ε Argus	8 20	49.9	50.2	49.8	48.7	47.5	46.5	45.9	45.7	46.4	47.4	48.9	50.4	51.4	21	−59	14.2	14.4	14.6	14.7	14.7	14.7	14.5	14.4	14.2	14.2	14.2	14.3	14.4		1.7
22	λ Argus	9 4	56.2	56.7	56.7	56.2	55.5	54.8	54.5	54.3	54.7	55.4	56.5	57.7	58.6	22	−43	5.5	5.6	5.8	5.9	6.0	5.9	5.8	5.7	5.6	5.5	5.5	5.6	5.7		2.2
23	β Argus	9 12	19.5	20.2	19.9	18.7	17.0	15.4	14.0	13.4	13.7	14.9	16.9	18.9	20.6	23	−69	22.1	22.3	22.5	22.6	22.7	22.7	22.6	22.5	22.3	22.2	22.2	22.2	22.4	Miaplacidus	1.8
24	α Hydræ	9 23	29.4	30.0	30.1	29.9	29.5	29.1	28.9	28.9	29.2	29.8	30.7	31.6	32.5	24	− 8	17.6	17.8	17.8	17.9	17.9	17.9	17.8	17.8	17.7	17.7	17.7	17.8	17.9	Alphard	2.2
25	α Leonis	10 3	55.8	56.5	56.8	56.7	56.4	56.1	55.8	55.7	56.0	56.4	57.2	58.2	59.2	25	+12	22.6	22.5	22.5	22.5	22.5	22.6	22.6	22.6	22.6	22.5	22.4	22.3	22.2	Regulus	1.3
26	α Urs. Maj.	10 58	36.3	37.8	38.5	38.4	37.6	36.6	35.7	35.1	34.9	35.4	36.5	38.1	40.0	26	+62	11.9	12.0	12.1	12.2	12.3	12.4	12.3	12.2	12.1	11.9	11.7	11.6	11.6	Dubhe	2.0
27	β Leonis	11 44	47.8	18.8	49.3	19.5	49.4	49.1	48.8	48.6	48.5	48.6	49.1	50.1	51.0	27	+15	2.3	2.2	2.2	2.2	2.3	2.3	2.3	2.4	2.3	2.3	2.2	2.0	31.9	Denebola	2.2
28	α Crucis	12 21	55.3	57.0	58.0	58.5	58.4	57.7	56.8	55.8	55.1	55.0	55.8	57.3	59.2	28	−62	37.8	38.0	38.1	38.3	38.5	38.6	38.6	38.6	38.5	38.3	38.2	38.2	38.2	Acrux	1.1
29	γ Crucis	12 26	30.2	31.7	32.6	33.1	33.1	32.5	31.8	31.1	30.5	30.5	31.1	32.4	34.0	29	−56	38.4	38.5	38.7	38.9	39.0	39.1	39.1	39.1	39.0	38.9	38.8	38.7	38.8		1.6
30	β Crucis	12 42	48.5	50.1	51.2	51.8	51.8	51.3	50.6	49.7	49.1	48.9	49.5	50.7	52.5	30	−59	13.6	13.7	13.9	14.1	14.2	14.3	14.3	14.3	14.2	14.1	14.0	38.8	14.0		1.5
31	ε Urs. Maj.	12 50	21.4	22.9	24.0	24.5	24.4	23.7	23.0	22.1	21.5	21.2	21.6	22.6	24.0	31	+56	24.5	24.5	14.5	24.7	24.8	24.9	25.0	24.9	24.8	24.7	24.5	24.3	24.2	Alioth	1.7
32	ζ Urs. Maj.	13 20	33.5	35.0	36.1	36.8	36.8	36.3	35.6	34.7	34.0	33.6	33.8	34.6	35.9	32	+55	21.4	21.4	21.4	21.5	21.7	21.8	21.8	21.8	21.7	21.6	21.4	21.2	21.1	Mizar	2.2
33	α Virginis	13 20	46.4	47.5	48.2	48.7	48.9	48.9	48.7	48.4	48.1	47.9	48.2	48.9	49.8	33	−10	43.5	43.6	43.7	43.7	43.7	43.7	43.7	43.7	43.6	43.6	43.6	43.7	43.8	Spica	1.2
34	θ Centauri	14 1	44.1	45.4	46.3	47.0	47.4	47.5	47.8	46.8	46.4	46.1	40.2	46.9	48.0	34	−35	57.4	57.5	77.6	57.7	57.8	57.8	57.9	57.9	57.8	57.7	57.7	57.7	57.7		2.3
35	α Bootis	14 11	50.0	51.1	51.9	52.6	52.9	52.9	52.7	52.3	51.9	51.6	51.6	52.0	52.9	35	+19	36.9	36.8	36.8	36.8	36.9	36.9	37.0	37.0	37.0	37.0	36.9	36.7	36.6	Arcturus	0.2

TABLE IV.

PROPORTIONAL PARTS.

Interval 2 hours.	0	10	20	30	40	50	60	70	80	90	100	110	120	Interval 24 hours.
m														h m
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 0
1	0	0	0	0	0	0	0	1	1	1	1	1	1	12
2	0	0	0	0	1	1	1	1	1	2	2	2	2	24
3	0	0	0	1	1	1	2	2	2	2	2	3	3	36
4	0	0	1	1	1	2	2	2	3	3	3	4	4	48
5	0	0	1	1	2	2	2	3	3	4	4	5	5	1 0
6	0	0	1	2	2	2	3	4	4	4	5	6	6	12
7	0	1	1	2	2	3	4	4	5	5	6	6	7	24
8	0	1	1	2	3	3	4	5	5	6	7	7	8	36
9	0	1	2	2	3	4	4	5	6	7	8	8	9	48
10	0	1	2	2	3	4	5	6	7	8	8	9	10	2 0
11	0	1	2	3	4	5	6	6	7	8	9	10	11	12
12	0	1	2	3	4	5	6	7	8	9	10	11	12	24
13	0	1	2	3	4	5	6	8	9	10	11	12	13	36
14	0	1	2	4	5	6	7	8	9	10	12	13	14	48
15	0	1	2	4	5	6	8	9	10	11	12	14	15	3 0
16	0	1	3	4	5	7	8	9	11	12	13	15	16	12
17	0	1	3	4	6	7	8	10	11	13	14	16	17	24
18	0	2	3	4	6	8	9	10	12	14	15	16	18	36
19	0	2	3	5	6	8	10	11	13	14	16	17	19	48
20	0	2	3	5	7	8	10	12	13	15	17	18	20	4 0
21	0	2	4	5	7	9	10	12	14	16	18	19	21	12
22	0	2	4	6	7	9	11	13	15	16	18	20	22	24
23	0	2	4	6	8	10	12	13	15	17	19	21	23	36
24	0	2	4	6	8	10	12	14	16	18	20	22	24	48
25	0	2	4	6	8	10	12	15	17	19	21	23	25	5 0
26	0	2	4	6	9	11	13	15	17	20	22	24	26	12
27	0	2	4	7	9	11	14	16	18	20	22	25	27	24
28	0	2	5	7	9	12	14	16	19	21	23	26	28	36
29	0	2	5	7	10	12	14	17	19	22	24	27	29	48
30	0	2	5	8	10	12	15	18	20	22	25	28	30	6 0
31	0	3	5	8	10	13	16	18	21	23	26	28	31	12
32	0	3	5	8	11	13	16	19	21	24	27	29	32	24
33	0	3	6	8	11	14	16	19	22	25	28	30	33	36
34	0	3	6	8	11	14	17	20	23	26	28	31	34	48
35	0	3	6	9	12	15	18	20	23	26	29	32	35	7 0
36	0	3	6	9	12	15	18	21	24	27	30	33	36	12
37	0	3	6	9	12	15	18	22	25	28	31	34	37	24
38	0	3	6	10	13	16	19	22	25	28	32	35	38	36
39	0	3	6	10	13	16	20	23	26	29	32	36	39	48
40	0	3	7	10	13	17	20	23	27	30	33	37	40	8 0
41	0	3	7	10	14	17	20	24	27	31	34	38	41	12
42	0	4	7	10	14	18	21	24	28	32	35	38	42	24
43	0	4	7	11	14	18	22	25	29	32	36	39	43	36
44	0	4	7	11	15	18	22	26	29	33	37	40	44	48

Find the correction to be applied to the right ascension and declination of Jupiter on April 15, 1916, at $11^h 55^m 30^s$ a. m. local mean time, in Long. 81° 15′ W.
(Problem page 107.)

G. M. T. = $15^d 5^h 20^m.5$.

Difference of R. A. in 24^h = 54. Difference for Dec. in 24^h = 55.
With differences of 54 for R. A. and 55 for Dec. as arguments at top of page and the G. M. T. as argument at right-hand side of page.

Corr. R. A., for 50; $5^h 12^m$ = 11^s
Corr. for 54 = $+0^s.8$
Corr. for $5^h 20^m.5$ = $+0^s.3$

Total $+1^s.1$ $1^s.1$

R. A. (correction)........ $+12^s.1$

Corr. Dec., for 50; $5^h 12^m$ = 1′.1
Corr. for 55 = +0′.1
Corr. for $5^h 20^m.5$ = 0′.0

Total +0′.1 +0′.1

Dec. (correction).......... +1.′2

APPENDIX II.

A COLLECTION OF FORMS FOR WORKING DEAD RECKONING AND VARIOUS ASTRONOMICAL SIGHTS, WITH NOTES EXPLAINING THEIR APPLICATION UNDER ALL CIRCUMSTANCES.

(The figures in parenthesis refer to the Notes following these forms.)

FORM FOR DAY'S WORK, DEAD RECKONING.

Time.	Compass Course.	Var.	Dev.	Lee-way.	Total error.	True Course.	Patent log.	Dist.	N.	S.	E.	W.	Diff.(1) Long.

	Latitude. ° ′		*Longitude.* ° ′	
Left at departure (or noon)	......	(2) N. *or* S.	......	(2) E. *or* W.
Run to......	......	N. *or* S.	......	E. *or* W.
By D. R. at......	......	N. *or* S.	......	E. *or* W.
Run to......	......	N. *or* S.	......	E. *or* W.
By D. R. at......	......	N. *or* S.	......	E. *or* W.

FORM FOR TIME SIGHT OF SUN'S LOWER LIMB (SUMNER LINE).

h. m. s.
W. T. ....
C–W + ...
Chro. t. ....
C. C. ± ....
(10) G. M. T. ....
(6) Eq. t. ± ....
G. A. T. ....

° ′ ″
Obs. alt. ⨀ ....
Corr. ± ....
h ....
′ ″
(3) S. D. + ...
(4) I. C. + ...
+ ....
′ ″
dip − ....
p. & r. − ....
− ....
′ ″
Corr. ± ....

° ′ ″
Dec. .... N. *or* S.
″
H. D. ± ....
h.
G. M. T. ....
′ ″
Corr. ± ....
° ′ ″
Dec. .... N. *or* S.
° ′ ″
(5) *p* ....

m. s.
Eq. t. ....
s.
H. D. ± ....
h.
G. M. T. ....
s.
Corr. ± ....
m. s.
Eq. t. ....

° ′ ″
h ....
L_1 .... log sec ....
p .... log cosec ....
2).........
s_1 .... log cos ....
s_1-h .... log sin ....
2)..........
h. m. s.
G. A. T. ....
L. A. T.₁ .... log sin $\frac{1}{2} t_1$ ....
(7) Long.₁ {h. m. s. .... ° ′ ″ ....} E. *or* W.

° ′ ″
(8) L_2 .... log sec ....
log cosec ....
(9) s_2 .... log cos ....
s_2-h .... log sin ....
2)..........
h. m. s.
G. A. T. ....
L. A. T.₂ .... log sin $\frac{1}{2} t_2$ ....
Long.₂ {h. m. s. .... ° ′ ″ ....} E. *or* W.

FORM FOR TIME SIGHT OF A STAR (SUMNER LINE).

		h. m. s.	
W. T.		....	
C–W	+	....	
		———	
Chro. t.		....	
C. C.	±	....	
		———	
(10) G. M. T.		....	
R. A. M. S.	+	....	
Red. (Tab. 9)	+	....	
		———	
G. S. T.		....	
R. A. ✱		....	
		———	
(11) H. A. from Gr.		....	E. *or* W.

		° ′ ″
Obs. alt.	✱	....
Corr.	±	....
		———
h		....
		———
		′ ″
(4) I. C	+	....
		———
		′ ″
dip	−	....
ref.	−	....
		———
	−	....
		———
		′ ″
Corr.	±	....

	h. m. s.	
R. A.	....	
	———	
	° ′ ″	
Dec.	....	N. *or* S.
	———	
	° ′ ″	
(5) *p*	....	

	° ′ ″		
h	....		
L_1	....	log sec	....
p	....	log cosec	....
	———		
	2)................		
	———		
s_1	....	log cos	....
s_1-h	....	log sin	....
	———		———
	h. m. s.		2)............
Gr. H. A.	....	E. *or* W.	———
(12) H. A.$_1$	....	E. *or* W. log sin ½ t_1	....
	———		
(13) Long.$_1$	{ h. m. s. .... ° ′ ″ .... }	E. *or* W.	

	° ′ ″		
(6) L_2	....	log sec	....
		log cosec	....
(7) s_2	....	log cos	....
s_2-h	....	log sin	....
	———		———
	h. m. s.		2)............
Gr. H. A.	....		———
H. A.$_2$	....	log sin ½ t_2	....
	———		
Long.$_2$	{ h. m. s. .... ° ′ ″ .... }	E. *or* W.	

FORM FOR TIME SIGHT OF A PLANET (SUMNER LINE).

		h. m. s.	
W.T.		....	
C–W	+	....	
		———	
Chro. t.		....	
C. C.	±	....	
		———	
(10) G. M. T.		....	
R. A. M. S.	+	....	
Red. (Tab. 9)	+	....	
		———	
G. S. T.		....	
R. A. ✱		....	
		———	
(11) H. A. from Gr.		....	E. *or* W.

		° ′ ″
Obs. alt.	✱	....
Corr.	±	....
		———
h		....
		———
		′ ″
(14) par.	+	....
(4) I. C.	+	....
		———
	+	....
		———
		′ ″
dip	−	....
ref.	−	....
		———
	−	....
		———
		′ ″
Corr.	±	....

		h. m. s.
R. A.		....
		———
		s.
H. D.	±	....
		h.
G. M. T		....
		———
		s.
Corr.	±	....
		———
		h. m. s.
R. A.		....

		° ′ ″	
Dec.		....	N. *or* S.
		———	
		″	
H. D.	±	....	
		h.	
G. M. T		....	
		———	
		′ ″	
Corr.	±	....	
		———	
		° ′ ″	
Dec.		....	N. *or* S.
		———	
		° ′ ″	
(5) *p*		....	

For the remainder of the work, by which the hour angles and thence the longitudes are found, employ the method given under "Form for Time Sight of a Star (Sumner Line)."

FORM FOR TIME SIGHT OF MOON'S LOWER LIMB (SUMNER LINE).

	h. m. s.		° ′ ″		h. m. s.		° ′ ″
W. T.	....	Obs. alt.	☾.......	(16) R. A.	....	(16) Dec.	.... N. or S.
C—W	+.......						
			′ ″		s.		″
Chro. t.	....	(16) S. D.	+.......	H. D.	+.......	H. D.	±.......
C. C.	±.......	Aug.	+.......		m.		m.
		(4) I. C.	+.......	G. M. T.	±.......	G. M. T.	±.......
(10) G. M. T.	....						
R. A. M. S.	+.......		+.......		s.		′ ″
Red. (Tab. 9)	+.......			Corr.	±.......	Corr.	±.......
			′ ″		h. m. s.		° ′ ″
G. S. T.	....	dip	−.......				
R. A. ☾	....			R. A.	....	Dec.	.... N. or S.
			′ ″				
(11) H. A. from Gr.	.... E. or W.	1st corr.	±.......			(5) p	....
			° ′ ″				
		Approx. alt.	....				
		p. & r. (Tab. 24)	+.......				
		h	....				

For the remainder of the work, by which the hour angles and thence the longitudes are found, employ the method given under "Form for Time Sight of a Star (Sumner Line)."

FORM FOR MERIDIAN ALTITUDE OF SUN'S LOWER LIMB.

	° ′ ″		′ ″		h. m. s.		° ′ ″
Obs. alt.	☉.......	(3) S. D.	+.......	L. A. T.	....	Dec.	.... N. or S.
Corr.	±.......	(4) I. C.	+.......	Long.	....		″
h	....		+.......	G. A. T.	....	H. D.	±.......
				Eq. t.	....		h.
	° ′ ″		′ ″			G. M. T.	±.......
(17) z	.... N. or S.	dip.	−.......	G. M. T.	....		′ ″
d	.... N. or S.	p. & r.	−.......			Corr.	±.......
Lat.	.... N. or S.		−.......				° ′ ″
			′ ″			Dec.	.... N. or S.
		Corr.	±.......				

FORM FOR MERIDIAN ALTITUDE OF A STAR.

	° ′ ″		′ ″		° ′ ″
Obs. alt.	✱.......	(4) I. C.	+.......	Dec.	.... N. or S.
Corr.	±.......		′ ″		
h	....	dip	−.......		
		ref.	−.......		
(17) z	.... N. or S.				
d	.... N. or S.		−.......		
Lat.	.... N. or S.		′ ″		
		Corr.	±.......		

FORM FOR MERIDIAN ALTITUDE OF A PLANET.

	° ′ ″		′ ″		h. m.		° ′ ″
Obs. alt.	✱.......	(14) par.	+.......	G. M. T., Gr. trans.	....	Dec.	.... N. or S.
Corr.	±.......	(4) I. C.	+.......	Corr. for Long.	±.......		″
h	....		+.......	L. M. T., local trans.	....	H. D.	±.......
				Long.	±.......		h.
	° ′ ″		′ ″			G. M. T.	....
(17) z	.... N. or S.	dip	−.......	G. M. T., local trans.	....		
d	.... N. or S.	ref.	−.......				′ ″
						Corr.	±.......
Lat.	.... N. or S.		−.......				
			′ ″				° ′ ″
		Corr.	±.......			Dec.	.... N. or S.

FORM FOR MERIDIAN ALTITUDE OF MOON'S LOWER LIMB.

	° ′ ″	
h	....	
	° ′ ″	
(17) z	....	N. or S.
d	....	N. or S.
Lat.	....	N. or S.

	° ′ ″
Obs. alt. ☾	....
	′ ″
(15) S. D.	+ ....
Aug.	+ ....
(4) I. C.	+ ....
	+ ....
	′ ″
dip	− ....
	′ ″
1st corr	± ....
	° ′ ″
Approx. Alt.	....
p. & r. (Tab. 24)	+ ....
h	....

	h. m.
G. M. T., Gr. trans.	......
Corr. for Long. (Tab. 11)	± ......
L. M. T., local trans.	......
Long.	± ......
G. M. T., local trans.	......

	° ′ ″	
(16) Dec.	....	N. or S.
	″	
H. D.	±	
	m.	
G. M. T.	±	
	′ ″	
Corr.	±	
	° ′ ″	
Dec.	....	N. or S.

ALTERNATIVE FORM FOR MERIDIAN ALTITUDE OF A BODY. (18)

	± 90° 00′ 00″	
(19) Dec.	±	
Corr.	±	
Constant	±	
Obs. Alt.	±	
Lat.	....	N. or S.

Rules for signs.

Case I.	Lat. & Dec. same name, Lat. greater	+90° + Dec. − Corr. − Alt.
Case II.	Lat. & Dec. same name, Dec. greater	−90° + Dec. + Corr. + Alt.
Case III.	Lat. and Dec. opposite names	+90° − Dec. − Corr. − Alt.
Case IV.	Lower transit	+90° − Dec. + Corr. + Alt.

FORM FOR LATITUDE SIGHTS OF SUN'S LOWER LIMB (SUMNER LINE).

	h. m. s.
W. T.	....
C-W	± ....
Chro. t.	....
C. C.	± ....
(15) G. M. T.	....
(6) Eq. t.	± ....
G. A. T.	....
Long.$_1$	± ....
L. A. T.$_1$	....
(20) t_1	h. m. s. .... ° ′ ″ ....
	h. m. s.
(11) Long.$_2$	± ....
L. A. T.$_2$	....
t_2	h. m. s. .... ° ′ ″ ....

	° ′ ″
Obs. alt.	⊙ ....
Corr.	± ....
h	....
	′ ″
(3) S. D.	+ ....
(4) I. C.	+ ....
	+ ....
	′ ″
dip	− ....
p. & r.	− ....
	− ....
	′ ″
Corr.	± ....

	° ′ ″	
Dec.	....	N. or S.
	″	
H. D.	±	
	h.	
G. M. T.	....	
	′ ″	
Corr.	±	
	° ′ ″	
Dec.	....	N. or S.

	m. s.
Eq. t.	....
	s.
H. D.	± ....
	h.
G. M. T.	....
	s.
Corr.	± ....
	m. s.
Eq. t.	....

φ′ φ″ Method.

	° ′ ″			
t_1	....		log sec	
d	....		log tan	log cosec ......
h	....			log sin ....
(22) φ_1''	....	N. or S.	log tan	log sin ....
φ_1'	....	N. or S.		log cos ....
Lat.$_1$	....	N. or S.		
	° ′ ″			
t_2	....		log sec	
d	....		log tan	log cosec ......
h	....			log sin ....
φ_2''	....	N. or S.	log tan	log sin ....
φ_2'	....	N. or S.		log cos ....
Lat.$_2$	....	N. or S.		

Reduction to Meridian.

	″				
(28) a	....				
	° ′ ″			° ′ ″	
h	....		h	....	
(29) at_1^2	±		at_2^2	±	
H_1	....		H_2	....	
	° ′ ″			° ′ ″	
(17) z_1	....	N. or S.	z_2	....	
d	....	N. or S.	d	....	
Lat.$_1$	....	N. or S.	Lat.$_2$	....	N. or S.

FORM FOR LATITUDE SIGHTS OF A STAR (SUMNER LINE).

	h. m. s.	
W. T.	....	
C-W	+.........	
Chro. t.	....	
C. C.	±.........	
(10) G. M. T.	....	
R. A. M. S.	+.........	
Red. (Tab.9)	+.........	
G. S. T.	....	
R. A.*	....	
(11) H. A. from Gr.	....	E. *or* W.
(25) Long.₁	....	E. *or* W.
t_1	h. m. s. .... ° ′ ″	E. *or* W.
	h. m. s.	
(21) Long.₂	....	E. *or* W.
t_2	h. m. s. .... ° ′ ″	E. *or* W.

	° ′ ″
Obs. alt.*	....
Corr.	±.........
h	....
	′ ″
(4) I. C.	+.........
	′ ″
dip	−.........
ref.	−.........
	−.........
	′ ″
Corr.	±.........

	h. m. s.	
R. A.	....	
	° ′ ″	
Dec.	....	N. *or* S.

For the remainder of the work, by which the latitudes are found from either the φ′ φ″ formula or the reduction to the meridian, employ the methods given under "Form for Latitude Sights of Sun's Lower Limb (Sumner Line)."

FORM FOR LATITUDE SIGHTS OF A PLANET (SUMNER LINE).

	h. m. s.	
W. T.	....	
C-W	+.........	
Chro. t.	....	
C. C.	±.........	
(10) G. M. T.	....	
R. A. M. S.	+.........	
Red. (Tab.9)	+.........	
G. S. T.	....	
R. A.*	....	
(11) H. A. from Gr.	....	E. *or* W.
(25) Long.₁	....	E. *or* W.
t_1	h. m. s. .... ° ′ ″	E. *or* W.
	h. m. s.	
(21) Long.₂	....	E. *or* W.
t_2	h. m. s. .... ° ′ ″	E. *or* W.

	° ′ ″
Obs. alt. *	....
Corr.	±.........
h	....
	′ ″
(14) par.	+.........
(4) I. C.	+.........
	+.........
	′ ″
dip	−.........
ref.	−.........
	−.........
Corr.	±.........

	h. m. s.		° ′ ″	
R. A.	....	Dec.	....	N. *or* S.
	s.		″	
H. D.	±.........	H. D.	±.........	
	h.		h.	
G. M. T.	....	G. M. T.	....	
	s.		′ ″	
Corr.	±.........	Corr.	±.........	
	h. m. s.		° ′ ″	
R. A.	....	Dec.	....	N. *or* S.

For the remainder of the work, by which the latitudes are found from either the φ′ φ″ formula or the reduction to the meridian, employ the methods given under "Forms for Latitude Sights of Sun's Lower Limb (Sumner Line)."

FORM FOR LATITUDE SIGHTS OF MOON'S LOWER LIMB (SUMNER LINE).

	h. m. s.		° ′ ″		*h. m. s.*		° ′ ″
W. T.	....	Obs. alt. ☾	....	(15) R. A.	....	(16) Dec.	......N. *or* S.
C–W	+..........						
			′ ″		*s.*		″
Chro. t.	....	(13) S. D.	+........	H. D.	+........	H. D.	±......
C. C.	±..........	Aug.	+........		*m.*		*m.*
		(4) I. C.	+........	G. M. T.	±........	G. M. T.	±......
(10) G. M. T.	....						
R. A. M. S.	+..........		+........		*s.*		′ ″
Red. (Tab. 9)	+..........			Corr.	±........	Corr.	±......
			′ ″				
G. S. T.	....	dip	−........		*h. m. s.*		° ′ ″
R. A. ☾	....			R. A.	....	Dec.	......N. *or* S.
			′ ″				
(11) H. A. from Gr.	.... E. *or* W.	1st Corr.	±........				
(25) Long.$_1$	.... E. *or* W.						
			° ′ ″				
t_1	*h. m. s.* .... ° ′ ″ .... E. *or* W.	Approx. alt.	....				
		p. & r. (Tab. 24)	+........				
			° ′ ″				
		h	....				
	h. m. s.						
Long.$_2$	.... E. *or* W.						
t_2	*h. m. s.* .... ° ′ ″ .... E. *or* W.						

For the remainder of the work, by which the latitudes are found from either the φ' φ'' formula or the reduction to the meridian, employ the methods given under "Forms for Latitude Sights of Sun's Lower Limb (Sumner Line)."

FORM FOR FINDING THE TIME OF HIGH (OR LOW) WATER.

	d. h. m.
G. M. T. of Greenwich transit	....
Corr. for Long. (Tab. 11)	±............
L. M. T. of local transit	....
Lunitidal int. (App. IV)	+............
L. M. T. of high (or low) water	....

FORM FOR FINDING THE CALCULATED ALTITUDE AND THE ALTITUDE DIFFERENCE FOR LAYING DOWN THE SUMNER LINE BY THE METHOD OF SAINT HILAIRE FROM A SIGHT OF THE SUN'S LOWER LIMB.

(SINE—COSINE FORMULA.[1])

		h. *m.* *s.*				° ′ ″				*m.* *s.*
W. T.		....		Dec.		....	N. *or* S.	Eq. t.		....
C–W	+	....				″				*s.*
				H. D.	±	....		H. D.	±	....
Chro. t.		....				*h.*				*h.*
C. C.	±	....		G. M. T.		....		G. M. T.		....
						′ ″				*s.*
(10) G. M. T.		....		Corr.	±	....		Corr.	±	....
(6) Eq. t.	±	....				° ′ ″				*m.* *s.*
G. A. T.		....		*d*		....	±	Eq. t.		....
		....								
Long. of assumed Pos.		....	E. *or* W.							

		h. *m.* *s.*			° ′ ″						
L. A. T.=*t*		....	=		....				log cos	....	±
				L ±	....	log sin	....	±	log cos	....	
		° ′ ″									
Obs. alt.	⊙	....		*d* ±	....	log sin	....	±	log cos	....	
I. C.	+	....				(Sum) log A	....	±	log B	....	±
Corr. (Tab. 46)	±	....				A ±	....		B ±	....	
Obs. *h*		....							A ±	....	
Calculated *h*		....			....	nat. sin		=	A + B	....	
Alt. Diff.		....									

FORM FOR FINDING THE CALCULATED ALTITUDE AND THE ALTITUDE DIFFERENCE FOR LAYING DOWN THE SUMNER LINE BY THE METHOD OF SAINT HILAIRE FROM A SIGHT OF THE SUN'S LOWER LIMB.

(COSINE—HAVERSINE FORMULA.[2])

		h. *m.* *s.*				° ′ ″				*m.* *s.*
W. T.		....		Dec.		....	N. *or* S.	Eq. t.		....
C—W.	+	....		H. D.	±	′ ″				*s.*
						....		H. D.	±	....
Chro. t.		....				*h*				*h.*
C. C.	±	....		G. M. T.		....		G. M. T.		....
						′ ″				*s.*
(10) G. M. T.		....		Corr.	±	....		Corr.	±	....
(6) Eq. t.	±	....				° ′ ″				*m.* *s.*
G. A. T.		....		*d*	±	....		Eq. t.		....
Long. of assumed Pos.		....	E. *or* W.							
		h. *m.* *s.*								° ′ ″
L. A. T.=*t*		....		log hav		....		Obs. alt.	⊙	....
		° ′ ″								
L		....		log cos		....		I. C.	+	....
d		....		log cos		....		Corr. (Tab. 46).	±	....
				log hav *θ*		....	(Sum)	Obs. *h*		....
				nat hav *θ*		....		Calculated *h*		....
L∼*d*		....		nat hav		....		Alt. Diff.		....
z		....		nat hav		....	(Sum)			
Calculated *h* =90°−*z*		....								

---

[1] Sine—cosine formula: $\sin h = \sin L \sin d + \cos L \cos d \cos t$
$= \quad A \quad + \quad B$

[2] Cosine—haversine formula: $\text{hav}\, z = \text{hav}\,(L \sim d) + \cos L \cos d \;\text{hav}\, t$
$= \text{hav}\,(L \sim d) + \text{hav}\,\theta$

FORM FOR FINDING THE CALCULATED ALTITUDE AND THE ALTITUDE DIFFERENCE FOR LAYING DOWN THE SUMNER LINE BY THE METHOD OF SAINT HILAIRE FROM A SIGHT OF THE SUN'S LOWER LIMB.

(37) (HAVERSINE FORMULA.[1])

		h. m. s.	
W. T.		....	
C—W	+	....	
Chro. t.		....	
C. C.	±	....	
(10) G. M. T.		....	
(9) Eq. t.	±	....	
G. A. T.		....	
Long of assumed Pos.		....	E. or W.
L. A. T.—t		....	

		° ′ ″		
Dec.		....	N. or S.	
		″		
H. D.	±	....		
		h		
G. M. T.		....		
		′ ″		
Corr	±	....		
		° ′ ″		
Dec.		....	N. or S.	
		° ′ ″		
(6) P. D.		....		
co. L.		....		
co. L.+ P. D.		....	nat hav	....
co. L.— P. D.		....	nat hav	....

		m. s.
Eq. t.		....
		s
H. D.	±	....
		h
G. M. T.		....
		s
Corr	±	....
		m. s.
Eq. t.		....

		° ′ ″
Obs. Alt.	☉	....
I. C.	+	....
Corr. (Tab. 46)	±	....
Obs. h		....
Calculated h		....
Alt. Diff.		....

nat hav A	....	(Diff.)
log hav A	....	
log hav t	....	
log hav B	....	(Sum)
nat hav B	....	
nat hav (co. L—P. D.)	....	
nat hav z	....	(Sum)
	° ′ ″	
z	....	
Calculated h =90°—z	....	

FORM FOR FINDING THE CALCULATED ALTITUDE AND THE ALTITUDE DIFFERENCE FOR LAYING DOWN THE SUMNER LINE BY THE METHOD OF SAINT HILAIRE FROM A SIGHT OF A STAR.

(SINE-COSINE FORMULA.[2])

		h. m. s.	
W. T.		....	
C-W	+	....	
Chro. t.		....	
C. C.	±	....	
(10) G. M. T,		....	
R. A. M. S,	+	....	
Red. (Tab. 9)	+	....	
G. S. T.		....	
R. A.*		....	
(11) H. A.* from Gr.		....	E. or W.
(12) Long. of assumed Pos.		....	E. or W.
t		h. m. s. ° ′ ″	

		° ′ ″
Obs. alt.*		....
I. C.	+	....
Corr. (Tab. 46)	−	....
Obs. h		....

	° ′ ″	
Dec. (d)	....	N. or S.
	h. m. s.	
R. A.	....	

	° ′ ″				
t	....	....		log cos	..........±
L ±	....	log sin	........±	log cos	....
d ±	....	log sin	........±	log cos	....
	(Sum)	log A	........±	log B	..........±
		A ±	....	B ±	....
	° ′ ″			A ±	....
Calculated h	....				
Obs. h	....				
Alt. Diff.	....	nat sin=	A+B		....

---

[1] Haversine formula: hav z = {hav (co. L + P. D.)— hav (co. L—P. D.)}hav t + hav (co. L—P. D.)
= hav B + hav (co. L—P. D.); where hav B=hav A hav t, and hav A=hav (co. L+P. D.)—hav (co. L—P. D.)

[2] Sine—cosine formula: sin h =sin L sin d + cos L cos d cos t
= A + B

FORM FOR FINDING THE CALCULATED ALTITUDE AND THE ALTITUDE DIFFERENCE FOR LAYING DOWN THE SUMNER LINE BY THE METHOD OF SAINT HILAIRE FROM A SIGHT OF A STAR.

(COSINE-HAVERSINE FORMULA.[1])

	h. m. s.		*h. m. s.*		° ′ ″
W. T.	....	*t*	.... log hav	Dec. (*d*)	........N. *or* S.
			° ′ ″		*h. m. s.*
C-W.	+........	L	.... log cos	R. A.	....
Chro. t.	....	*d*	.... log cos		
					° ′ ″
C. C.	±........		log hav *θ*........ (Sum)	Obs. alt. *	....
(10) G. M. T.	....		nat hav *θ*........	I. C.	+........
R. A. M. S.	+........	L~*d*	.... nat hav	Corr. (Tab. 46)	−........
Red. (Tab. 9)	+........	*z*	.... nat hav ....(Sum)	Obs. *h*	....
G. S. T.	....				
			° ′ ″		
R. A. *	....	Calculated *h*	.... =90°−*z*		
(11) H. A. * from Gr.	........E. *or* W.	Obs. *h*	....		
(25) Long. of assumed Pos.	........E. *or* W.	Alt. diff.	....		
t	....				

FORM FOR FINDING THE CALCULATED ALTITUDE AND THE ALTITUDE DIFFERENCE FOR LAYING DOWN THE SUMNER LINE BY THE METHOD OF SAINT HILAIRE FROM A SIGHT OF A STAR.

(27) (HAVERSINE FORMULA.[2])

	h. m. s.		° ′ ″		*h. m. s.*
W. T.	....	Dec.	........N. *or* S.	R. A.	....
C-W	+........	(8) P. D.	....		
					° ′ ″
Chro. t.	....	co. L.	....	Obs. alt. *	....
C. C.	±........	co. L+P. D.	........nat hav	I. C.	+........
(10) G. M. T.	....	co. L−P. D.	........nat hav	Corr. (Tab. 46)	−........
R. A. M. S.	+........		nat hav A........ (Diff.)	Obs. *h*	....
Red. (Tab. 9)	+........		log hav A........	Calculated *h*	....
			h. m. s.		
G. S. T.	....	*t*	........log hav........	Alt. diff.	....
R. A. *	....		log hav B........ (Sum)		
(11) H. A. * from Gr.	........E. *or* W.		nat hav B........		
			° ′ ″		
(25) Long. of assumed Pos.	........E. *or* W.	co. L−P. D.	........nat hav		
t	....	*z*	........nat hav ....(Sum)		
			° ′ ″		
		Calculated *h* =90°− *z*	....		

---

[1] Cosine—haversine formula: $\text{hav } z = \text{hav } (L \sim d) + \cos L \cos d \text{ hav } t$
$= \text{hav } (L \sim d) + \text{hav } \theta$

[2] Haversine formula: $\text{hav } z = \{\text{hav (co. L + P. D.)} - \text{hav (co. L} - \text{P. D.)}\} \text{ hav } t + \text{hav (co. L} - \text{P. D.)}$
$= \text{hav B} + \text{hav (co. L} - \text{P. D.)}$; where $\text{hav B} = \text{hav A hav } t$, and $\text{hav A} = \text{hav (co. L+ P. D.)} - \text{hav (co. L} - \text{P. D.)}$

FORM FOR FINDING THE CALCULATED ALTITUDE AND THE ALTITUDE DIFFERENCE FOR LAYING DOWN THE SUMNER LINE BY THE METHOD OF SAINT HILAIRE FROM A SIGHT OF A PLANET.

(SINE-COSINE FORMULA[1])

	h. m. s.		h. m. s.		° ′ ″		° ′ ″
W. T.	....	R. A.	....	Dec.	.........N. or S.	Obs. alt.	....
			s.		″		
C-W	+.........	H. D.	±.........	H. D.	±.........	I. C.	+.........
			h.		h.		
Chro. t.	....	G. M. T.	....	G. M. T.	....	Corr. (Tab. 46). −	....
			s.		′ ″		
C. C.	±.........	Corr.	±.........	Corr.	±.........	Obs. h	....
(10) G. M. T.	....	R. A.	....	d	.........±	Calculated h	....
R. A. M. S.	+.........					Alt. Diff.	....
			° ′ ″				
Red. (Tab. 9)	+.........	t	....	....		log cos	.........±
G. S. T.	....	L	±.........	log sin	.........±	log cos	....
R. A. ∗	....	d	±.........	log sin	.........±	log cos	....
(11) H. A. ∗ from Gr.	.........E. or W.			(Sum) log A	.........±	log B	.........±
(12) Long. of assumed Pos.	.........E. or W.			A	±.........	B	±.........
t	h. m. s. ° ′ ″		° ′ ″			A	±.........
		Calculated h	....	nat. sin		=A+B	....

FORM FOR FINDING THE CALCULATED ALTITUDE AND THE ALTITUDE DIFFERENCE FOR LAYING DOWN THE SUMNER LINE BY THE METHOD OF SAINT HILAIRE FROM A SIGHT OF A PLANET.

(COSINE-HAVERSINE FORMULA.[2])

	h. m. s.		h. m. s.				h. m. s.		° ′ ″
W. T.	....	t	....	log hav	....	R. A.	....	Dec.	.........N. or S.
			° ′ ″				s.		″
C-W	+.........	L	....	log cos	....	H. D.	±.........	H. D.	±.........
							h.		h.
Chro. t.	....	d	....	log cos	....	G. M. T.	....	G. M. T.	....
							s.		′ ″
C. C.	±.........			log hav θ	.........(Sum)	Corr.	±.........	Corr.	±.........
(10) G. M. T.	....			nat hav θ	.........}	R. A.	....	d	.........±
R. A. M. S.	+.........	L∼d	....	nat hav	.........}				
Red. (Tab. 9)	+.........	z	....	nat hav	.........(Sum)				
			° ′ ″						° ′ ″
G. S. T.	....							Obs. alt.	....
R. A. ∗	....	Calculated h	.........=90°−z					I. C.	+.........
								Corr. (Tab. 46) −	....
(11) H. A. ∗ from Gr.	....	E. or W.						Obs. h	....
(12) Long. of assumed Pos.	....	E. or W.						Calculated h	....
t	....							Alt. Diff.	....

---

[1] Sine—cosine formula: $\sin h = \sin L \sin d + \cos L \cos d \cos t$

$= A + B$

[2] Cosine—haversine formula: $\text{hav } z = \text{hav } (L \sim d) + \cos L \cos d \text{ hav } t$

$= \text{hav } (L \sim d) + \text{hav } \theta$

FORM FOR FINDING THE CALCULATED ALTITUDE AND THE ALTITUDE DIFFERENCE FOR LAYING DOWN THE SUMNER LINE BY THE METHOD OF SAINT HILAIRE FROM A SIGHT OF A PLANET.

(10) (HAVERSINE FORMULA.)[1]

	h. m. s.			° ′ ″			° ′ ″			
W. T.	....		Dec.	....	N. or S.	co. L + P. D.	....	nat hav	....	
				″						
C–W	+..........		H. D.	±..........		co. L − P. D.	....	nat hav	....	
				h						
Chro. t.	....		G. M. T.	....				nat hav A.	....	(Diff.)
				′ ″						
C. C.	±..........		Corr.	±..........				log hav A.	....	
				° ′ ″			h. m. s.			
(10) G. M. T.	....		Dec.	....	N. or S.	t	....	log hav	....	
R. A. M. S.	+..........		(5) P. D.	....				log hav B.	....	(Sum)
Red. (Tab. 9)	+..........		co. L	....				nat hav B.	....	
				° ′ ″			° ′ ″			
G. S. T.	....		co. L + P. D.	....		co. L − P. D.	....	nat hav	....	
R. A. *	....		co. L − P. D.	....		z	....	nat hav	....	(Sum)
				h. m. s.						
(11) H. A. * from Gr.	....	E. or W.	R. A.	....						
				s.			° ′ ″		° ′ ″	
(12) Long. of assumed Pos.	....	E. or W.	H. D.	±..........		Calculated h = 90° − z	....	Obs. alt.	....	
				h.						
t	....		G. M. T.	....		Obs. h	....	I. C.	+........	
				s.						
			Corr.	±..........		Alt. Diff.	....	Corr. − (Tab. 46)	....	
				h. m. s.						
			R. A.	....				Obs. h	....	

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[1] Haversine formula: $\text{hav } z = \{\text{hav (co. L + P. D.)} - \text{hav (co. L} - \text{P. D.)}\} \text{ hav } t + \text{hav (co. L} - \text{P. D.)}$
$= \text{hav B} + \text{hav (co. L} - \text{P. D.)}$; where hav B = hav A hav t, and hav A = hav (co. L + P. D.) − hav (co. L − P. D.)

NOTES RELATING TO THE FORMS.

1. It is not necessary to convert departure into difference of longitude for each course; it will suffice to make one conversion for the sum of all the departures used in bringing forward the position to any particular time.

2. In D. R. it will be found convenient to work Lat. and Long. in minutes and tenths, rather than in minutes and seconds.

3. If upper limb is observed, the correction for S. D. should be negative, instead of positive.

4. A positive I. C. has been assumed for illustration throughout the forms; if negative, it should be included with the *minus* terms of the correction.

5. To obtain p, subtract Dec. from 90° if of same name as Lat.; add to 90° if of opposite name

6. Sign of Eq. t. that of application to *mean* time.

7. If G. A. T. is later than L. A. T., Long. is west; otherwise it is east.

8. If Lat. is exactly known, a second latitude need not be employed.

9. s_2 and $s_2 - h$ may be obtained by applying half the difference between L_1 and L^2 with proper sign, to s_1 and $s_1 - h$, respectively.

10. The G. M. T. must represent the proper number of hours from noon, the beginning of the astronomical day; to obtain this it may be necessary to add 12^h to the Chro. t.

11. H. A. from Greenwich is the difference between G. S. T. and R. A., and should be marked W. if the former is greater: otherwise, E.

12. Local H. A. is marked E. or W., according as the body is east or west of the meridian at time of observation.

13. Subtract local hour angle from Greenwich hour angle to obtain longitude; that is, change name of local hour angle and combine algebraically.

14. The forms include a correction for the parallax of a planet, but in most cases this is small, and may be omitted. When used, take hor. par. from Naut. Alm. and reduce to observe altitude by Table 17. The semidiameter of a planet may be disregarded in sextant work if the *center* of the body is brought to the horizon line.

15. If upper limb is observed, the corrections for S. D. and Aug. should be negative, instead of positive.

16. R. A. and Dec. are to be picked out of Naut. Alm. for nearest hour of G. M. T., and to be corrected for the number of minutes and tenths.

17. Mark zenith distance N. or S. according as zenith is north or south of the body observed; mark Dec. according to its name, subtracting it from 180° for cases of lower transit; then, in combining the two for Lat., have regard to their names.

18. This form enables "Constant" to be worked up before sight is taken, and gives latitude directly on completion of meridian observation. Longitude and altitude at transit must be known in advance with sufficient accuracy for correcting terms.

19. The details of obtaining Dec. at transit and correction for altitude are shown in the meridian altitude forms for each of the various bodies.

20. In an a. m. sight subtract L. A. T. from 24^h to obtain t; in a p. m. sight L. A. T. is equal to t.

21. If Long. is exactly known, a second longitude need not be employed.

22. Mark ϕ'' N. or S. according to name of Dec., and subtract it from 180° when body is nearer to lower than to upper transit; mark ϕ' N. or S. according as zenith is north or south of the body; then combine for Lat. having regard to the names

23. Take a from Table 26 and at^2 from Table 27.

24. Add for upper, subtract for lower transits.

25. Subtract longitude from Greenwich hour angle to obtain local hour angle; that is, change name of longitude and combine algebraically.

26. Add for west, subtract for east longitude.

27. As the trigonometric functions are all haversines in this solution, the abbreviation, hav, might be omitted, and the abbreviations, nat. and log, might be employed to indicate the natural haversine and the log haversine, respectively.

APPENDIX III.

EXPLANATION OF CERTAIN RULES AND PRINCIPLES OF MATHEMATICS OF USE IN THE SOLUTION OF PROBLEMS IN NAVIGATION.

DECIMAL FRACTIONS.

Fractions, or *Vulgar Fractions*, are expressions for any assignable part of a unit; they are usually denoted by two numbers, placed one above the other, with a line between them; thus $\frac{1}{4}$ denotes the fraction one-fourth, or one part out of four of some whole quantity, considered as divisible into four equal parts. The lower number, 4, is called the *denominator* of the fraction, showing into how many parts the whole is divided; and the upper number, 1, is called the *numerator*, and shows how many of those equal parts are contained in the fraction. It is evident that if the numerator and denominator be varied in the same ratio the value of the fraction will remain unaltered; thus, if both the numerator and denominator of the fraction $\frac{1}{4}$ be multiplied by 2, 3, 4, etc., the fractions arising will be $\frac{2}{8}$, $\frac{3}{12}$, $\frac{4}{16}$, etc., all of which are evidently equal to $\frac{1}{4}$.

A *Decimal Fraction* is a fraction whose denominator is always a unit with some number of ciphers annexed and the numerator any number whatever; as $\frac{3}{10}$, $\frac{3}{100}$, $\frac{14}{1000}$, etc. And as the denominator of a decimal is always one of the numbers 10, 100, 1000, etc., the necessity for writing the denominator, may be avoided by employing a point; thus, $\frac{3}{10}$ is written .3, and $\frac{14}{100}$ is written .14; the *mixed* number $3\frac{14}{100}$, consisting of a whole number and a fractional one, is written 3.14.

In setting down a decimal fraction the numerator must consist of as many places as there are ciphers in the denominator; and if it has not so many figures the defect must be supplied by placing ciphers before it; thus, $\frac{16}{100}$=.16, $\frac{16}{1000}$=.016, $\frac{16}{10000}$=.0016, etc. And as ciphers on the right-hand side of integers increase their value in a tenfold proportion, as 2, 20, 200, etc., so when set on the left hand of decimal fractions they decrease their value in a tenfold proportion, as .2, .02, .002, etc.; but ciphers set on the right hand of these fractions make no alteration in their value; thus, .2 is the same as .20 or .200.

The common arithmetical operations are performed the same way in decimals as they are in integers, regard being had only to the particular notation to distinguish the integral from the fractional part of a sum.

Addition of Decimals.—Addition of decimals is performed exactly like that of whole numbers, placing the numbers of the same denomination under each other, in which case the separating decimal points will range straight in one column.

EXAMPLES.

	Miles.	Feet.	Inches.
Add:	26.7	1.26	272.3267
	32.15	2.31	.0134
	143.206	1.785	2.1576
	.003	2.0	31.4
Sum:	202.059	7.355	305.8977

Subtraction of Decimals.—Subtraction of decimals is performed in the same manner as in whole numbers, observing to set the figures of the same denomination and the separating points directly under each other.

EXAMPLES.

From:	31.267	36.75	1.254	1364.2
Take:	2.63	.026	.316	25.163
Difference:	28.637	36.724	.938	1339.037

Multiplication of Decimals.—Multiply the numbers together as if they were whole numbers, and point off as many decimals from the right hand as there are decimals in both factors together; and when it happens that there are not so many figures in the product as there must be decimals, then prefix such number of ciphers to the left hand as will supply the defect.

EXAMPLE I.

Multiply 3.25 by 4.5

3.25
4.5
1625
1300
Answer: 14.625

In one of the factors is one decimal, and in the other two; their sum, 3, is the number of decimals of the product.

EXAMPLE II.

Multiply .17 by .06

.17
.06
Answer: .0102

In each of the factors are two decimals; the product ought therefore to contain 4; and, there being only three figures in the product, a cipher must be prefixed.

Example III.

Multiply 0.5 by 0.7

0.5
0.7

Answer: 0.35

Example IV.

Multiply .18 by 24

.18
24

72
36

Answer: 4.32

Division of Decimals.—Division of decimals is performed in the same manner as in whole numbers. The number of decimals in the quotient must be equal to the excess of the number of decimals of the dividend above those of the divisor; when the divisor contains more decimals than the dividend, ciphers must be affixed to the right hand of the latter to make the number equal or exceed that of the divisor.

Example I.

Divide 14.625 by 3.25

3.25)14.625(4.5
13 00

1625
1625

In this example there are two decimals in the divisor and three in the dividend; hence, there is one decimal in the quotient.

Example II.

Divide 3.1 by .0062

Previous to the division affix three ciphers to the right hand of 3.1, to make the number of decimals in the dividend equal the number in the divisor.

.0062)3.1000(500
3 10

000

Example III.

Divide 17.256 by 1.16

1.16)17.25600(14.875+
11 6

565
464

1016
928

880
812

680
580

100

By pursuing the operation further the quotient may be carried out as many decimal places as desired.

Multiplication of Decimals by Contraction.—The operation of multiplication of decimal fractions may be very much abbreviated when it is not required to retain any figures beyond a certain order or place; this will constantly occur in reducing the elements taken from the Nautical Almanac from Greenwich noon to later or earlier instants of time.

In multiplying by this method, omit writing down that part of the operation which involves decimal places below the required order, but mental note should be made of the product of the first discarded figure by the multiplying figure, and the proper number of tens should be carried over to insure accuracy in the lowest decimal place sought.

Example: Required the reduction for the sun's declination for $7^h.43$, the hourly difference being $58''.18$, where the product is required to the second decimal.

By ordinary method.	*By contraction.*
$58''.18$	$58''.18$
$7^h.43$	$7^h.43$
17454	1.74
23272	23.27
40726	407.26
$432''.2774$	$432.''27$

In the contracted method, for the multiplier .03 it is not necessary to record the product of any figures in the multiplicand below units; for the multiplier .4, none below tenths; but in each case observe the product of the left-hand one of the rejected figures and carry forward the number of tens.

RULES AND PRINCIPLES OF MATHEMATICS.

Reduction of Decimals.—To reduce a vulgar fraction to a decimal, add any number of ciphers to the numerator and divide it by the denominator; the quotient will be the decimal fraction. The decimal point must be so placed that there may be as many figures to the right hand of it as there were added ciphers to the numerator. If there are not so many figures in the quotient place ciphers to the left hand to make up the number.

Example I.

Reduce $\frac{1}{50}$ to a decimal.

$$50)1.00$$

$$.02 \text{ Answer.}$$

Example II.

Reduce $\frac{3}{8}$ to a decimal.

$$8)3.000$$

$$.375 \text{ Answer.}$$

Example III.

Reduce 3 inches to the decimal of a foot.
Since 12 inches=1 foot this fraction is $\frac{3}{12}$.

$$12)3.00$$

$$.25 \text{ Answer.}$$

Example IV.

Reduce 15 minutes to the decimal of an hour.
Since $60^{m} = 1^{h}$, this fraction is $\frac{15}{60}$.

$$60)15.00$$

$$.25 \text{ Answer.}$$

Example V.

Reduce 17^{m} 22^{s} to the decimal of an hour.

$$22^{s} = \frac{22^{m}}{60} = 0^{m}.37.$$

$$17^{m}\ 37 = \frac{17^{h}.37}{60} = 0^{h}.289+ \text{Answer.}$$

Any decimal may be reduced to lower denominations of the same quantity by multiplying it by the number representing the relation between the respective denominations.

Example VI. Reduce 7.231 days to days, hours, minutes, and seconds.

$$\begin{array}{rrrl}
0^{d}.231 & 0^{h}.544 & 0^{m}.640 & \\
24 & 60 & 60 & \\
\hline
924 & 32^{m}.640 & 38^{s}.400 & \text{Answer: } 7^{d}\ 5^{h}\ 32^{m}\ 38^{s}.4. \\
462 & & & \\
\hline
5^{h}.544 & & &
\end{array}$$

GEOMETRY.

Geometry is the science which treats of the description, properties, and relations of magnitudes, of which there are three kinds; viz, a *line*, which has only length without either breadth or thickness; a *surface*, comprehended by length and breadth; and a *solid*, which has length, breadth, and thickness.

A *point*, considered mathematically, has neither length, breadth, nor thickness; it denotes position simply.

A *line* has length without breadth or thickness.

A *surface* has length and breadth without thickness.

A *solid* has length, breadth, and thickness.

A *straight* or *right line* is the shortest distance between two points on a plane surface.

A *plane surface* is one in which, any two points being taken, the straight line between them lies wholly within that surface.

Parallel lines are such as are in the same plane and if extended indefinitely never meet.

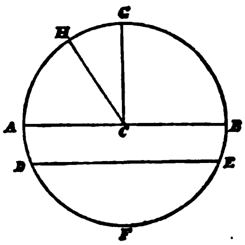

Fig. 82.

A *circle* is a plane figure bounded by a curved line of which every point is equally distant from a point within called the *center*. The bounding curve of the circle is called the *circumference*.

The *radius* of a circle, or *semidiameter*, is a right line drawn from the center to the circumference, as AC (fig. 82); its length is that distance which is taken between the points of the compasses to describe the circle.

A *diameter* of a circle is a right line drawn through the center and terminated at both ends by the circumference, as ACB, its length being twice that of the radius. A diameter divides the circle and its circumference into two equal parts.

An *arc* of a circle is any portion of the circumference, as DFE.

The *chord* of an arc is a straight line joining the ends of the arc. It divides the circle into two unequal parts, called *segments*, and is a chord to them both; thus, DE is the chord of the arcs DFE and DGE.

A *semicircle*, or half circle, is a figure contained between a diameter and the arc terminated by that diameter, as AGB or AFB.

Any part of a circle contained between two radii and an arc is called a *sector*, as GOH.

A *quadrant* is half a semicircle, or one-fourth part of a whole circle, as CAG.

All circles are supposed to have their circumferences divided into 360 equal parts, called degrees; each degree is divided into 60 equal parts, called minutes; and each minute into 60 equal parts, called seconds; an arc is measured by the number of degrees, minutes, and seconds that it contains.

A *sphere* is a solid bounded by a surface of which every point is equally distant from a point within, which, as in the circle, is called the *center*. Substituting *surface* for *circumference*, the definitions of the *radius* and *diameter*, as given for the circle, apply for the sphere.

An *angle* is the inclination of two intersecting lines, and is measured by the arc of a circle intercepted between the two lines that form the angle, the center of the circle being the point of intersection.

A *right angle* is one that is measured by a quadrant, or 90°. An *acute angle* is one which is less than a right angle. An *obtuse angle* is one which is greater than a right angle.

A *plane triangle* is a figure contained by three straight lines in the same plane.

When the three sides are equal, the triangle is called *equilateral;* when two of them are equal, it is called *isosceles*. When one of the angles is 90°, the triangle is said to be *right-angled*. When each angle is less than 90°, it is said to be *acute-angled*. When one is greater than 90°, it is said to be *obtuse-angled*. Triangles that are not right-angled are generally called *oblique-angled*.

A *quadrilateral* figure is one bounded by four sides. If the opposite sides are parallel, it is called a *parallelogram*. A parallelogram having all its sides equal and its angles right angles is called a *square*. When the angles are right angles and only the opposite sides equal, it is called a *rectangle*.

In a right-angled triangle the side opposite the right angle is called the *hypotenuse*, one of the other sides is called the *base*, and the third side is called the *perpendicular*. In any oblique-angled triangle, one side having been assumed as a base, the distance from the intersection of the other two sides to the base or the base extended, measured at right angles to the latter, is the perpendicular. In a parallelogram, one of the sides having been assumed as the base, the distance from its opposite side, measured at right angles to its direction, is the perpendicular. The term *altitude* is sometimes substituted for *perpendicular* in this sense.

Every section of a sphere made by a plane is a circle. A *great circle* of a sphere is a section of the surface made by a plane which passes through its center. A *small circle* is a section by a plane which intersects the sphere without passing through the center.

A great circle may be drawn through any two points on the surface of a sphere, and the arc of that circle lying between those points is shorter than any other distance between them that can be measured upon the surface. All great circles of a sphere have equal radii, and all bisect each other.

The extremities of that diameter of the sphere which is perpendicular to the plane of a circle are called the *poles* of that circle. In the case of a small circle the poles are named the *adjacent pole* and the *remote pole*. All circles of a sphere that are parallel have the same poles. All points in the circumference of a circle are equidistant from the poles. In the case of a great circle, the poles are 90° distant from every point of the circle.

Assuming any great circle as a *primary*, all great circles which pass through its poles are called its *secondaries*. All secondaries cut the primary at right angles.

Useful Formulæ Derived from Geometry.—In these formulæ the following abbreviations are adopted:

b, base of triangle or parallelogram.
h, perpendicular of triangle or parallelogram.
l, height of cylinder or cone.
π, ratio of diameter to circumference ($= 3.141593$).
r, radius of sphere or circle.
d, diameter of sphere or circle.
A, major axis of ellipse.
a, minor axis of ellipse.
s, side of a cube.

Area of parallelogram $= b \times h$.
Area of triangle $= \frac{1}{2} b \times h$.
Area of any right-lined figure = sum of the areas of the triangles into which it is divided.
Sum of three angles of any triangle = 180°.
Circumference of circle $= 2\pi r$, or πd.
Area of circle $= \pi r^2$, or $\frac{\pi d^2}{4}$.
Angle subtended by arc equal to radius $= 57°.29578$.

Volume of sphere $= \frac{\pi d^3}{6}$.
Surface of sphere $= \pi d^2$, or $4\pi r^2$.
Area of ellipse $= \frac{\pi A a}{4}$.
Volume of cube $= s^3$.
Volume of cylinder $=$ Area of base $\times\, l$.
Volume of pyramid or cone $=$ Area of base $\times \frac{l}{3}$.

TRIGONOMETRIC FUNCTIONS.

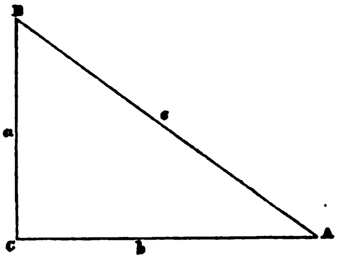

FIG. 83.

The *trigonometric functions* of the angle formed by any two lines are the *ratios* existing between the sides of a right triangle formed by letting fall a perpendicular from any point in one line upon the other line; no matter what point is chosen for the perpendicular nor which line, the ratios, and therefore the respective functions, will be the same for any given angle.

Let ABC (fig. 83) be a plane right triangle in which C is the right angle: A and B, the other angles; c, the hypotenuse; a and b the sides opposite the angles A and B, respectively. In considering the functions of the angle A, its opposite side, a, is regarded as the perpendicular, and its adjacent side, b, as the base; for the angle B, b is the perpendicular and a the base. Then the various ratios are designated as follows:

$\frac{a}{c}$, or $\frac{\text{perpendicular}}{\text{hypotenuse}}$, is called the *sine* of the angle A, abbreviated sin A;

$\frac{b}{c}$, or $\frac{\text{base}}{\text{hypotenuse}}$, is called the *cosine* of the angle A, abbreviated cos A;

$\frac{a}{b}$, or $\frac{\text{perpendicular}}{\text{base}}$, is called the *tangent* of the angle A, abbreviated tan A;

$\frac{b}{a}$, or $\frac{\text{base}}{\text{perpendicular}}$, is called the *cotangent* of the angle A, abbreviated cot A;

$\frac{c}{b}$, or $\frac{\text{hypotenuse}}{\text{base}}$, is called the *secant* of the angle A, abbreviated sec A;

$\frac{c}{a}$, or $\frac{\text{hypotenuse}}{\text{perpendicular}}$, is called the *cosecant* of the angle A, abbreviated cosec A;

1—cosine A, is called the *versed sine* of A, abbreviated vers A.

1—sine A, is called the *co-versed sine* of A, abbreviated covers A.

½ (1—cosine A) is called the haversine of A, abbreviated hav A.

The following relations may be seen to exist between the various functions:

$$\frac{1}{\sin A} = 1 \div \frac{a}{c} = \frac{c}{a} = \text{cosec } A;$$

$$\frac{1}{\cos A} = 1 \div \frac{b}{c} = \frac{c}{b} = \sec A;$$

$$\frac{1}{\tan A} = 1 \div \frac{a}{b} = \frac{b}{a} = \cot A;$$

$$\frac{\sin A}{\cos A} = \frac{a}{c} \div \frac{b}{c} = \frac{a}{b} = \tan A.$$

Hence the cosecant is the reciprocal of the sine, the secant is the reciprocal of the cosine, the cotangent is the reciprocal of the tangent, and the tangent equals the sine divided by the cosine.

The *complement* of an angle is equal to 90° minus that angle, and thus in the triangle ABC the angle B is the complement of A. The *supplement* is equal to 180° minus the angle.

From the triangle ABC, regarding the angle B, we have:

$$\sin B = \frac{b}{c} = \cos A;$$

$$\tan B = \frac{b}{a} = \cot A;$$

$$\sec B = \frac{c}{a} = \text{cosec } A.$$

Hence it may be seen that the sine of an angle is the cosine of the complement of that angle; the tangent of an angle is the cotangent of its complement, and the secant of an angle is the cosecant of its complement.

The functions of angles vary in sign according to the quadrant in which the angles are located.

Let AA′ and BB′ (fig. 84) be two lines at right angles intersecting at the point O, and let that point be the center about which a radius revolves from an initial position OB, successively passing the points A, B′, A′. In considering the angle made by this radius at any position, P′, P″, P‴, P⁗, with the line OB, its position of origin, the functions will depend upon the ratios existing between the sides of a right triangle whose base, *b*, will always lie within BB′, and whose perpendicular, *a*, will always be parallel to AA′, while its hypotenuse, *c* (of a constant length equal to that of the radius), will depend upon the position occupied by the radius. Now, if OB and OA be regarded as the positive directions of the base and perpendicular, respectively, and OB′ and OA′ as their negative directions, the sign of the hypotenuse being always positive, the sign of any function may be determined by the signs of the sides of the triangle upon which it depends.

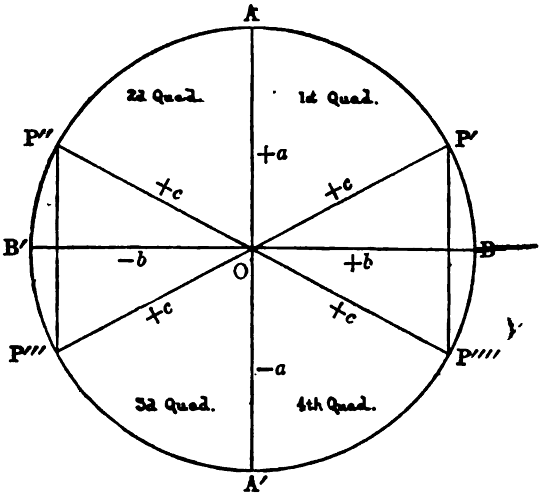

FIG. 84.

For example, the sine of the angle P″OB is $\frac{a}{c}$, and since a is positive the quantity has a positive value; its cosine is $\frac{b}{c}$, and as b is measured in a negative direction from O the cosine must therefore be negative.

In the first quadrant, between 0° and 90°, all quantities being positive, all functions will also be positive.

In the second quadrant, between 90° and 180°, sin A $\left(=\frac{a}{c}\right)$ is positive; cos A $\left(=\frac{b}{c}\right)$ has a negative value because b is negative; tan A $\left(=\frac{a}{b}\right)$ is also negative because of b. The cosecant, secant, and cotangent have, as in all cases, the same signs as the sine, cosine, and tangent, respectively, being the reciprocals of those quantities.

In the third quadrant, between 180° and 270°, sin A $\left(=\frac{a}{c}\right)$ and cos A $\left(=\frac{b}{c}\right)$ are both negative, because both a and b have negative values; tan A $\left(=\frac{a}{b}\right)$ is positive for the same reason.

In the fourth quadrant, between 270° and 360°, sin A $\left(=\frac{a}{c}\right)$ is negative, cos A $\left(=\frac{b}{c}\right)$ is positive, and tan A $\left(=\frac{a}{b}\right)$ is also negative.

From a consideration of the signs in the manner that has been indicated, the following relations will appear:

$$\sin A = \sin(180^\circ - A) = -\sin(180^\circ + A) = -\sin(360^\circ - A) = -\sin(-A).$$
$$\cos A = -\cos(180^\circ - A) = -\cos(180^\circ + A) = \cos(360^\circ - A) = \cos(-A).$$
$$\tan A = -\tan(180^\circ - A) = \tan(180^\circ + A) = -\tan(360^\circ - A) = -\tan(-A).$$
$$\sin A = \cos(90^\circ - A) = -\cos(90^\circ + A) = -\cos(270^\circ - A) = \cos(270^\circ + A).$$

Any similar relation may be deduced from the figure.

It is of great importance to have careful regard for the signs of the functions in all trigonometrical solutions.

LOGARITHMS.

In order to abbreviate the tedious operations of multiplication and division with large numbers, a series of numbers, called *Logarithms*, was invented by Lord Napier, by means of which the operation of multiplication may be performed by addition, and that of division by subtraction. Numbers may be involved to any power by simple multiplication and the root of any power extracted by simple division.

In Table 42 are given the logarithms of all numbers, from 1 to 9999; to each one must be prefixed an index, with a period or dot to separate it from the other part, as in decimal fractions; the logarithms of the numbers from 1 to 100 are given in that table with their indices; but from 100 to 9999 the index is left out for the sake of brevity; it may be supplied, however, by the general rule that the index of the logarithm of any integer or mixed number is always one less than the number of integral places in the natural number. Thus, the index of the logarithm of any number (integral or mixed) between 10 and

100 is 1; from 100 to 1000 it is 2; from 1000 to 10000 it is 3, etc.; the method of finding the logarithms from this table will be evident from the rules that follow:

To find the logarithm of any number less than 100, enter the first page of the table, and opposite the given number will be found the logarithm with its index prefixed. Thus, opposite 71 is 1.85126, which is its logarithm.

To find the logarithm of any number between 100 and 1000, find the given number in the left-hand column of the table of logarithms, and immediately under 0 in the next column is a number, to which must be prefixed the number 2 as an index (because the number consists of three places of figures), and the required logarithm will be found. Thus, if the logarithm of 149 was required, this number being found in the left hand column, against it, in the column marked 0 at the top (or bottom) is found 17319, prefixing to which the index 2, we have the logarithm of 149 = 2.17319.

To find the logarithm of any number between 1000 and 10000, find the three left-hand figures of the given number in the left-hand column of the table of logarithms, opposite to which, in the column that is marked at the top (or bottom) with the fourth figure, is to be found the required logarithm, to which must be prefixed the index 3, because the number contains 4 places of figures. Thus, if the logarithm of 1495 was required, opposite to 149, and in the column marked 5 at the top (or bottom) is 17464, to which prefix the index 3, and we have the logarithm, 3.17464.

To find the logarithm of any number above 10000, find the first three figures of the given number in the left-hand column of the table, and the fourth figure at the top or bottom, and take out the corresponding logarithm as in the preceding rule; take also the difference between this logarithm and the next greater, and multiply it by the remaining figure or figures of the number whose logarithm is sought, pointing off as many decimal places in the product as there are figures in the multiplier. To facilitate the calculation of the proportional parts several small tables are placed in the margin, which give the correction corresponding to the difference, and to the *fifth* figure of the proposed number. Thus, if the logarithm of 14957 was required, opposite to 149, and under 5, is 17464; the difference between this and the next greater number, 17493, is 29; this multiplied by 7 (the last figure of the given number) gives 203; pointing off the right-hand figure gives 20.3 (or 20) to be added to 17464, which makes 17484; to this, prefixing the index 4, we have the logarithm sought, 4.17484. This correction, 20, may also be found by inspection in the small table in the margin, marked at the top 29; opposite to the *fifth* figure of the number, 7, in the left-hand column, is the corresponding correction, 20, in the right-hand column.

Again, if the logarithm of 1495738 was required, the logarithm corresponding to 149 at the left, and 5 at the top, is, as in the last example, 17464; the difference between this and the next greater is 29; multiplying this by 738 (the given number excluding the first four figures) gives 21402; crossing off the three right-hand figures of this product (because the number 738 consists of three figures), we have the correction 21 to be added to 17464; and the index to be prefixed is 6, because the given number consists of 7 places of figures; therefore the required logarithm is 6.17485. This correction, 21, may be found as above, by means of the marginal table marked at the top 29, taking at the side 7.38 (or 7½ nearly), to which corresponds 21, as before.

To find the logarithm of any mixed decimal number, find the logarithm of the number, as if it were an integer, by the preceding rules, to which prefix the index of the integral part of the given number. Thus, if the logarithm of the mixed decimal 149 5738 was required, find the logarithm of 1495738, without noticing the decimal point; this, in the last example, was found to be 17485; to this prefix the index 2, corresponding to the integral part 149; the logarithm sought will therefore be 2.17485.

To find the logarithm of any decimal fraction less than unity, it must be observed that the index of the logarithm of any number less than unity is negative; but, to avoid the mixture of positive and negative quantities, it is common to borrow 10 in the index, which, in most cases, may afterwards be neglected in summing them with other indices; thus, instead of writing the index − 1, it is written + 9; instead of − 2 we may write + 8; and so on. In this way we may find the logarithm of any decimal fraction by the following rule: Find the logarithm of a fraction as if it were a whole number; see how many ciphers precede the first figure of the decimal fraction, subtract that number from 9, and the remainder will be the index of the given fraction. Thus the logarithm of 0.0391 is 8.59218 − 10; the logarithm of 0.25 is 9.39794 − 10; the logarithm of 0.0000025 is 4.39794 − 10, etc. In most cases the writing of − 10 after the logarithm may be dispensed with, as it will be quite apparent whether the logarithm has a positive or a negative index.

To find the number corresponding to any logarithm, seek in the column marked 0 at top and bottom the next smallest logarithm, neglecting the index; write down the number in the side column abreast which this is found, and this will give the first three figures of the required number; follow the line until the logarithm next smaller than the given one is found, and the fourth figure of the required number will be at the top and bottom of the column in which this stands; take the difference between this next smaller logarithm and the next larger one in the table, and also the difference between the next smaller logarithm and the given one; entering the small marginal table which has for its heading the first-named difference, and finding in the right-hand column of that table the last-named difference, there will appear abreast the latter, in the left-hand column, the fifth figure of the required number. Where it is desired to determine figures beyond the fifth for the corresponding number, the difference between the next lower logarithm and the given one may be divided by the difference between the next lower and next higher ones, and the quotient (disregarding the decimal point, but retaining any ciphers that may come between the decimal point and the significant figures) will be the fifth and succeeding figures of the number sought. Having found the figures of the corresponding number, point off from the left a number of figures which shall be one greater than the index number, and there place a decimal point. In this operation of placing the decimal point, proper account must be taken of the negative value of any index.

Thus, if the number corresponding to the logarithm 1.52634 were required, find 52634 in the column marked 0 at the top or bottom, and opposite to it is 336; now, the index being 1, the required number must consist of two integral places; therefore it is 33.6.

If the number corresponding to the logarithm 2.57345 were required, look in the column 0 and find in it, against the number 374, the logarithm 57287, and, guiding the eye along that line, find the given logarithm, 57345, in the column marked 5; therefore the mixed number sought is 3745, and since the index is 2, the integral part must consist of 3 places; therefore the number sought is 374.5. If the index be 1 the number will be 37.45, and if the index be 0 the number will be 3.745. If the index be 8, corresponding to a number less than unity, the number will be 0.03745.

Again, if the number corresponding to the logarithm 3.57811 were required, find, against 378 and under 5, the logarithm 57807, the difference between this and the next greater logarithm, 57818, being 11, and the difference between 57807 and the given logarithm, 57811, being 4; in the marginal table headed 11, find in the right-hand column the number 4, and abreast the latter appears the figure 4, which is the fifth figure of the required number; hence the figures are 37854; pointing off from the left 3 + 1 = 4 places, the number is 3785.4.

If the given logarithm were 5.57811, since the index 5 requires that there shall be six places in the whole number, it is desirable to seek accuracy to the sixth figure. The logarithmic part being the same as in the example immediately preceding, it is found as before that the first four figures are 3785, the difference between the next lower and next greater logarithms is 11, and between the next lower logarithm and the given one is 4; divide 4 by 11 and the quotient is .36; drop the decimal point, annex and point off, and the number required is found to be 378536.

It may be remarked that in using five-place logarithm tables it is not generally to be expected that results will be exact beyond the fifth figure.

To show, at one view, the indices corresponding to mixed and decimal numbers, the following examples are given:

Mixed number.	*Logarithms.*	*Decimal number.*	*Logarithms.*
40943. 0	Log. 4. 61218	0. 40943	Log. 9. 61218—10
4094. 3	Log. 3. 61218	0. 040943	Log. 8. 61218—10
409. 43	Log. 2. 61218	0. 0040943	Log. 7. 61218—10
40. 943	Log. 1. 61218	0. 00040943	Log. 6. 61218—10
4. 0943	Log. 0. 61218	0. 000040943	Log. 5. 61218—10

To perform multiplication by logarithms, add the logarithms of the two numbers to be multiplied and the sum will be the logarithm of their product.

EXAMPLE I.

Multiply 25 by 35.

25	Log. 1. 39794
35	Log. 1. 54407
Product, 875	Log. 2. 94201

EXAMPLE II.

Multiply 22.4 by 1.8.

22. 4	Log. 1. 35025
1. 8	Log. 0. 25527
Product, 40. 32	Log. 1. 60552

EXAMPLE III.

Multiply 3.26 by 0.0025.

3. 26	Log. 0. 51322
0. 0025	Log. 7. 39794
Product, 0. 00815	Log. 7. 91116

EXAMPLE IV.

Multiply 0.25 by 0.003.

0. 25	Log. 9. 39794
0. 003	Log. 7. 47712
Product, 0. 00075	Log. 6. 87506

In the last example, the sum of the two logarithms is really 16.87506—20; this is the same as 6.87506—10, or, remembering that the quantity is less than unity, simply 6.87506.

To perform division by logarithms, from the logarithm of the dividend subtract the logarithm of the divisor; the remainder will be the logarithm of the quotient.

EXAMPLE I.

Divide 875 by 25.

875	Log. 2. 94201
25	Log. 1. 39794
Quotient, 35	Log. 1. 54407

EXAMPLE II.

Divide 40.32 by 22.4.

40. 32	Log. 1. 60552
22. 4	Log. 1. 35025
Quotient, 1. 8	Log. 0. 25527

EXAMPLE III.

Divide 0.00815 by 0.0025.

0. 00815	Log. 7. 91116
0. 0025	Log. 7. 39794
Quotient, 3. 26	Log. 0. 51322

EXAMPLE IV.

Divide 0.00075 by 0.025.

0. 00075	Log. 6. 87506
0. 025	Log. 8. 39794
Quotient, 0. 03	Log. 8. 47712

In Example III both the divisor and dividend are fractions less than unity, and the divisor is the lesser; consequently the quotient is greater than unity. In Example IV both fractions are less than unity; and, since the divisor is the greater, its logarithm is greater than that of the dividend; for this reason it is necessary to borrow 10 in the index before making the subtraction, that is, to regard the logarithm of .00075 as 16.87506 — 20; hence the quotient is less than unity.

The *arithmetical complement* of the logarithm of a number, usually called the *cologarithm* of the number, and denoted by colog, is the remainder obtained by subtracting the logarithm of the number from the logarithm of unity. It is therefore the logarithm of the reciprocal of the number; and, since the effect of dividing by any number is the same as that of multiplying by its reciprocal, it follows that, in performing division by logarithms, we may either subtract the logarithm of the divisor or add the arithmetical complement of that logarithm. As the addition of a number of quantities can be performed in a single operation, while in subtraction the difference between only two quantities can be taken at a time, it is frequently a convenience to deal with the arithmetical complements rather than with the logarithms themselves.

EXAMPLE I.

Divide 875 by 25.

875.......................Log. 2.94201

25......Log. 1.39794....Colog. 8.60206

Quotient, 35.......................Log. 1.54407

EXAMPLE II.

Divide 0.00075 by 0.025.

0.00075.......................Log. 6.87506

0.025....Log. 8.39794....Colog. 1.60206

Quotient, 0.03.......................Log. 8.47712

EXAMPLE III.

Simplify the expression, $\frac{40.32\times.00815}{22.4\times.0025}$.

40.32.......................Log. 1.60552

.00815.......................Log. 7.91116

22.4.........Log. 1.35025....Colog. 8.64975

.0025.....Log. 7.39794....Colog. 2.60206

Result, 5.868.......................Log. 0.76849

To perform involution by logarithms, multiply the logarithm of the given number by the index of the power to which the quantity is to be raised; the product will be the logarithm of the power sought.

EXAMPLE I.

Required the square of 18.

18.......................Log. 1.25527

2

Answer, 324.......................Log. 2.51054

EXAMPLE II.

Required the square of 6.4.

6.4.......................Log. 0.80618

2

Answer, 40.96.......................Log. 1.61236

EXAMPLE III.

Required the cube of 13.

13.......................Log. 1.11394

3

Answer, 2197.......................Log. 3.34182

EXAMPLE IV.

Required the cube of 0.25.

0.25.......................Log. 9.39794

3

Answer, 0.015625.......................Log. 8.19382

In the last example, the full product of the multiplication of 9.39794—10 by 3 is 28.19382—30, which is equivalent to 8.19382—10.

To perform evolution by logarithms divide the logarithm of the number by the index of the power; the quotient will be the logarithm of the root sought. If the number whose root is to be extracted is a decimal fraction less than unity, increase the index of its logarithm by adding a number of tens which shall be less by one than the index of the power before making the division.

EXAMPLE I.

Required the square root of 324.

324.......................Log. 2)2.51055

Answer. 18.......................Log. 1.25527

EXAMPLE II.

Required the cube root of 2197.

2197.......................Log. 3)3.34183

Answer, 13.......................Log. 1.11394

EXAMPLE III.

Required the square root of 40.96.

40.96.......................Log. 2)1.61236

Answer, 6.4.......................Log. 0.80618

EXAMPLE IV.

Required the cube root of 0.015625.

0.015625.......................Log. 8.19382

Add 20 to the index....................3)28.19382

Answer, 0.25.......................Log. 9.39794

In the last example the logarithm 8.19382—10 was converted into its equivalent form of 28.19382—30, which, divided by 3, gives 9.39794—10.

To find the logarithm of any function of an angle, Table 44 must be employed. This table is so arranged that on every page there appear the logarithms of all the functions of a certain angle A, together with those of the angles 90° − A, 90° + A, and 180° − A; thus on each page may be found the logarithms of the functions of four different angles. The number of degrees in the respective angles are printed in bold-faced type, one in each corner of the page; the number of minutes corresponding appear in one column at the left of the page and in another at the right; the names of the functions to which the various logarithms correspond are printed at the top and bottom of the columns. The invariable rule must be to take the name of the function from the top or the bottom of the page, according as the number of degrees of the given angle is found at the top or bottom; and to take the minutes from the right or left hand column, according as the number of degrees is found at the right or left hand side of the page; or, more briefly, take names of functions and number of minutes, respectively, from the line and column nearest in position to the number of degrees.

Taking, as an example, the thirty-first page of the table, it will be found that 30° appears at the upper left-hand corner, 149° at the upper right-hand, 59° at the lower right-hand, and 120° at the lower left-hand corner. Suppose that it is desired to find the log. sine of 30° 10′; following the rule given, we find 10′ in the left-hand column and Sine at the top of the page, and abreast one and below the other is the required logarithm, 9.70115. But if the log. sine of 59° 10′ were sought, as 59° appears below and at the right of the page, the logarithm 9.93382 would be taken from the column marked Sine at the bottom and abreast 10′ on the right. It may also be seen that log. sin 30° 10′ = log. cos 59° 50′ = log. cos 120° 10′ = log. sin 149° 50′ = 9.70115, the equality of the functions agreeing with trigonometrical deductions; (in this statement numerical values only are regarded, and not signs; the latter must, of course, be taken into account in all operations).

EXAMPLE I.

Required the log. sine, cosecant, tangent, cotangent, secant, and cosine of 28° 37′.

Log. sin	9.68029	Log. cot	10.26313
Log. cosec	10.31971	Log. sec	10.05658
Log. tan	9.73687	Log. cos	9.94342

EXAMPLE II.

Required the log. sine, cosecant, tangent, cotangent, secant, and cosine of 75° 42′.

Log. sin	9.98633	Log. cot	9.40636
Log. cosec	10.01367	Log. sec	10.60730
Log. tan	10.59364	Log. cos	9.39270

When the angle of which the logarithmic function is required is given to seconds, it becomes necessary to interpolate between the logarithms given for the even minutes next below and next above; this may be done either by computation or (except in a few cases) by inspection of the table.

To interpolate by computation, let n represent the number of seconds, D the difference between the logarithms of the next lesser and next greater even minute, and d the difference between the logarithm of the next lesser even minute and that of the required angle. Then,

$$d = \frac{n}{60} \times \mathrm{D}.$$

It should be noted when the number of seconds is 30, 20, 15, or some similar number, permitting the reduction of the fraction $\frac{n}{60}$ to a simple value, such as ½, ⅓, ¼, as the interpolation by this method may thus be made with greater facility.

Having obtained the difference of the logarithm from that of the next lower even minute, it must be applied in the proper direction—that is, if the function is such that its logarithm increases as the angle increases, the logarithmic difference must be added; but if it decreases, then that difference must be subtracted.

For example, let it be required to find the log. sin and log. cosec of 30° 10′ 19″. The log. sin of 30° 10′ is 9.70115; the difference between this logarithm and that of the sine of 30° 11′ (9.70137) is + 22, which is D. Hence,

$$d = \frac{19}{60} \times (+22) = +7;$$

and the required logarithm is 9.70122. The log. cosec of 30° 10′ is 10.29885; the difference, D, between that and log. cosec 30° 11′ (10.29863) is −22. In this case

$$d = \frac{19}{60} \times (-22) = -7;$$

therefore, log. cosec 30° 10′ 19″ = 10.29878.

The method of interpolating by inspection consists in entering that column marked "Diff." which is adjacent to the one from which the logarithmic function for the next lower minute is taken, and finding, abreast the number in the left-hand minute column which corresponds to the seconds, the required logarithmic difference; and the latter is to be added or subtracted according as the logarithms increase or decrease with an increased angle. Thus, if it be required to find log. sin 30° 10′ 19″, find as before log. sin 30° 10′ = 9.70115, then, in the adjacent column headed "Diff." and abreast the number of seconds, 19, in the left-hand minute column will be found 7, the logarithmic difference; add this, as the function is increasing, and we have the required logarithm 9.70122. If log. cosec 30° 10′ 19″ be sought, find log. cosec 30° 10′ = 10.29885; then in the adjacent difference column, which is the same as was used for the sines, find as before the logarithmic difference, 7; and since this function decreases as the angle increases, this must be subtracted; therefore, log. cosec 30° 10′ 19″ = 10.29878.

This method of interpolation by inspection is not available in that portion of the table where the logarithmic differences vary so rapidly that no values will apply alike to all the angles on the same page; on such pages the difference for one minute is given in a column headed "Diff. 1′," instead of the usual difference for each second; in this case the interpolation must be made by computation, the given difference for one minute being D. In other parts of the table the interpolation by inspection may be liable to slight error because of the variation in logarithmic difference for different angles on the same page; but the tabulated values are sufficiently accurate for the usual calculations in navigation.

It will be evident that while the methods explained have contemplated entering the tables with a smaller angle and interpolating *ahead*, it would be equally correct to enter with a greater angle and nterpolate *back* for the proper number of minutes, making the requisite change in the sign of the icorrection.

EXAMPLE I.

Required the log. sine, cosine, and tangent of 42° 57′ 06″.

	For 42° 57′	d	For 42° 57′ 06″.
Log. sin	9.83338	+1	9.83339
Log. cos	9.86448	−1	9.86447
Log. tan	9.96890	+3	9.96893

EXAMPLE II.

Required the log. secant, cosecant, and cotangent of 175° 32′ 36″.

	For 175° 32′	d	For 175° 32′ 36″
Log. sec	10.00132	− 1	10.00131
Log. cosec	11.10858	+97	11.10955
Log. cot	11.10726	+98	11.10824

It should be observed that, for uniformity and convenience, all logarithms given in Table 44 have been increased by 10 in the index, and it is understood that −10 ought properly to be written after each; thus all logarithms under 10.00000 represent functions whose value is less than unity, and all over 10.00000 those greater than unity; for example, 11.10726 is the logarithm of a number in which the decimal point should be placed after the second figure from the left.

To find the angle corresponding to any logarithmic function, the process is the reverse of the one just described. Find, in the column marked with the name of the function, either at top or bottom, the two logarithms between which the given one falls; write down the degrees and minutes of the lesser of the two corresponding angles, which will be the degrees and minutes of the angle required. Call the difference between the two tabulated logarithms D, and the difference between the given logarithm and that which corresponds to the lesser angle, *d*; then if *n* represents the number of seconds, we have:

$$n = \frac{d}{D} \times 60.$$

Or, the same may be obtained by inspection (except where, as before explained, the differences for seconds are not tabulated) by finding, in the "Diff." column adjacent to that from which the logarithm was taken, the logarithmic difference, *d*, and noting the number of seconds abreast which it stands in the left-hand minute column.

Interpolation may be also made in the reverse direction from the next greater even minute.

Thus, if it be required to find the angle corresponding to log. sin 9.61400, we find log. sin 24° 16′, 9.61382, and log. sin 24° 17′, 9.61411; hence D=29, and d=18;

$$n = \frac{18}{29} \times 60 = 37;$$

and the angle is 24° 16′ 37″. Or, in adjacent column headed "Diff.," 18 would be found abreast 38, 39, or 40 (seconds) in the left-hand minute column—a correspondence sufficiently close for navigation work.

If the angle were known to be in the second quadrant, we find log. sin 155° 43′, 9.61411, and log. sin 155° 44′, 9.61382; here D=29, and d=11;

$$n = \frac{11}{29} \times 60 = 23;$$

therefore, the angle is 155° 43′ 23″. Or, in adjacent "Diff." column find, abreast 11, 23 or 24 seconds.

EXAMPLE I.

Find angles less than 90° corresponding to log. cot 10.33621, log. sec 10.11579, and log. cos 8.70542.

		°	′	d	″
Log. cot	10.33621	24	45	8	15
Log. sec	10.11579	40	00	4	22
Log. cos	8.70542	87	05	116	28

EXAMPLE II.

Find angles in second quadrant corresponding to log. tan 10.15593, log. sin 8.87926, and log. cosec 10.04944.

		°	′	d	″
Log. tan	10.15593	124	55	19	42
Log. sin	8.87926	175	39	69	25
Log. cosec	10.04944	116	49	3	27

The Hour Columns in Table 44 give the measure in time corresponding to twice the angular distance given in arc. Thus, abreast the angle 13° 00′ stands in the P. M. column $1^h\ 44^m\ 00^s$, corresponding in time to 2×13° 00′; and in the A. M. column $10^h\ 16^m\ 00^s$, which is the same subtracted from 12^h. These columns are of use in working the various formulæ which involve functions of half the hour angle. Interpolation for values intermediate to those given in the tables is made on the same principle as for the angular measure; this operation may be performed by inspection by the use of the small tables at the bottom of each page, where *n*, the number of seconds of time, is given in bold-faced type, and *d*, the logarithmic difference for the respective columns, appears below.

EXAMPLE I.

Given $t = 1^h\ 48^m\ 44^s$, find log. cot $\frac{1}{2}t$.

For $1^h\ 48^m\ 40^s$,	log. cot. $\frac{1}{2}t$	10.61687
Diff. for 4^s, Col. B	—	28
For $1^h\ 48^m\ 44^s$,	log. cot $\frac{1}{2}t$	10.61659

EXAMPLE II.

Given log. sin $\frac{1}{2}t$, 9.91394, find the Hour A. M. corresponding.

For 9.91389,		$4^h 39^m 12^s$
Diff. for 5, Col. C	-	5
For 9.91394,		4 39 07

MISCELLANEOUS USEFUL DATA.

Earth's Polar radius=6,356,583.8 meters.
Earth's Equatorial radius=6,378,206.4 meters.
Earth's Compression=$\frac{1}{293.465}$.
Earth's Eccentricity=0.0822719 ....log 8. 9152513.
Number of feet in one statute mile=5280................log 3. 7226339.
Number of feet in one nautical mile=6080.27...........log 3. 7839229.
Sine of 1″=0.00000485.....................................log 4. 6855749.
Sine of 1′=0.00029089......................................log 6. 4637261.
The Napierian base ε=2.7182818 ....log 0. 4342945.
The modulus of common logarithms=0.4342945 ....log 9. 6377843.
French meter in English feet, 3.2808333 ....log 0. 5159842.
French meter in English statute miles, 0.000621370 ....log 6. 7933503.
French meter in nautical miles, 0.000539568............log 6. 7320613.
1 pound Avoirdupois=7,000 grains Troy.
French gramme=0.00220606 Imperial pound Troy.
French kilogramme=0.0196969 English cwts.
Cubic inch of distilled water, in grains=252.458.
Cubic foot of water, in ounces Troy=908.8488.
Cubic foot of water, in pounds Troy=75.7374.
Cubic foot of water, in ounces Avoirdupois=997.1369691.
Cubic foot of water, in pounds Avoirdupois=62.3210606.
} Bar. 30.00 in.; ther. 62° F.
Length of pendulum which vibrates second at Greenwich, 39.1393 inches.

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

The following table contains the latitude and longitude of a large number of places, together with lunitidal intervals and tidal ranges at the more important ones. It is arranged geographically and followed by an alphabetical index.

The geographical position generally relates to some specified exact location, and is based upon the best available authority. The tidal data relate to the waters adjacent to the point whose latitude and longitude are given, being abstracted from the Tide Tables published by the United States Coast and Geodetic Survey.

The high-water and low-water lunitidal intervals represent the mean intervals between the moon's transit and the time of next succeeding high and low waters throughout a lunar month. The spring and neap ranges are the differences in height between high water and low water at spring and at neap tides. For those places where the tide is chiefly of a diurnal type, and where there is usually but one high and one low water during a lunar day, the tidal values are bracketed; in such cases the lunitidal intervals are for the semidiurnal part of the tide (which, however, is only appreciable for a few days when the moon is near the equator), and the range given in the column headed "Spg." does not, as in other cases, apply to the spring tide, but to the greatest periodic daily range, which usually occurs a day or two after the moon attains its extreme of declination, and is therefore near one of the tropics. As those places where the diurnal type predominates seldom experience large tidal effects, the general data furnished regarding such tides will suffice for the ordinary purpose of the navigator. The method of finding the time of high or low water from this table is illustrated in article 504, Chapter XX.

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

EAST COAST OF NORTH AMERICA.

Coast.	Place.	Lat. N.	Long. W.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Labrador.	Salisbury Island: E. pt	63 27 00	76 30 00				
	Nottingham Island: S. pt	63 06 00	77 50 00	8 58	2 46	13.5	6.1
	Digges Island: W. extreme	62 37 00	78 08 00				
	Cape Wostenholme	62 35 00	77 33 00				
	Charles Island: E. pt	62 48 00	74 00 00				
	W. pt	62 50 00	75 20 00				
	Cape Weggs	62 30 00	74 03 00				
	Prince of Wales Sound: Center of ent	62 07 00	72 25 00				
	Cape of Hopes Advance	61 18 00	70 02 00				
	Akpatok Island: E. pt	60 10 00	67 05 00				
	Green Island: NE. pt	60 40 00	67 50 00				
	Button Islands: N. pt	60 52 00	64 40 00				
	Cape Chidleigh	60 33 00	64 12 00				
	Resolution Island: S. pt., Hutton h'dl'd	61 21 00	65 00 00				
	E. pt., C. Resolution	61 40 00	64 30 00				
	Black Head	60 00 00	64 28 00				
	Eclipse Harbor: E. side	59 48 00	64 07 15	8 00	1 48	5.0	2.0
	Nachvack Bay: Islands off entrance	59 07 00	63 20 00	7 00	0 48	5.2	2.1
	Saddle Island	57 35 00	61 20 00				
	Port Manvers: Entrance	57 00 00	62 07 00				
	Nain: Church	56 32 45	61 40 13	7 00	0 48	6.5	3.0
	Hopedale Harbor: Hill to E'd	55 27 04	60 12 34	5 30	11 43	6.9	3.2
	Aillick Harbor: Cape Mokkivik	55 13 33	59 08 01				
	Cape Harrison: N. extreme	54 55 50	57 56 40				
	Indian Harbor: Obsy	54 26 55	57 12 40	6 10	12 23	7.0	3.2
	Outer Gannet Island: Summit	54 00 05	56 31 31				
	Gready Harbor	53 50 00	56 23 00				
	Cartwright Harbor: Caribou Castle	53 42 37	56 59 50				
	Indian Tickle: Summit	53 34 25	55 58 39	6 27	0 15	6.0	2.8
	Roundhill Island: Summit	53 26 00	55 35 48				
	Occasional Harbor: E. summit of Twin I	52 40 07	55 44 29	6 38	0 26	5.0	2.3
	Cape St. Lewis: SE. pt	52 21 16	55 38 08	6 30	0 18	3.5	1.6
	Battle Islands: NE. extreme, SE. I	52 15 36	55 32 20				
	Table Head	52 06 00	55 41 00				
	Belle Isle: Lighthouse	51 53 00	55 22 10				
Newfoundland.	Cape Bauld: Lighthouse	51 38 48	55 25 12				
	Bell Island: S. end	50 42 10	55 35 30				
	Cape St. John: Gull Island light	49 59 54	55 21 33				
	Tilt Cove, Union Copper Mine	49 53 00	55 37 17				
	Funk Island: Summit	49 45 29	53 10 56				
	Offer Wadham: Lighthouse	49 35 40	53 45 00				
	Toulinguet Islands: Lighthouse	49 41 20	54 47 35				
	Seldom-come-by Harbor: Ship Hill	49 36 50	54 12 00				
	Cape Freels: Gull I	49 15 20	53 25 12				
	Greenspond Island	49 04 20	53 37 45				
	Cape Bonavista: Lighthouse	48 42 01	53 04 42				
	Catalina Harbor: Green I. lighthouse	48 30 15	53 02 40				
	Bonaventure Head	48 16 55	53 23 35				
	Hearts Content: Lighthouse	47 53 10	53 23 20	7 23	1 11	4.1	1.9
	Baccalieu Island: Lighthouse	48 08 58	52 47 42				
	Harbor Grace: Lighthouse on beach	47 42 45	53 08 11	7 15	1 03	3.3	1.5
	Cape St. Francis: Lighthouse	47 48 30	52 47 20				
	St. Johns Harbor: Chain Rock Battery	47 34 02	52 40 54	7 12	1 01	3.3	1.5
	Cape Race: Lighthouse	46 39 24	53 04 30	6 50	0 38	6.5	3.0
	Cape Pine: Lighthouse	46 37 04	53 31 55				
	Trepassey Harbor: Shingle Neck	46 43 20	53 22 10	6 50	0 38	6.6	3.1
	Cape St. Mary: Lighthouse	46 49 34	54 11 42	8 20	2 08	7.2	3.3
	Little Placentia Harbor: W. side Coopers Cove	47 17 55	53 58 43				
	Burin Island: Lighthouse	47 00 26	55 08 49				
	Laun: Gr. Laun R. C. Church	46 56 30	55 32 00	8 05	1 53	7.0	3.2

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

EAST COAST OF NORTH AMERICA—Continued.

Coast.	Place.	Lat. N.	Long. W.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Newfoundland.	St. Pierre: U. S. Coast Survey Station	46 46 51	56 10 36	8 23	2 11	6.6	3.1
	Brunet Island: Mercers Hd. lighthouse	47 15 30	55 51 40	8 53	2 41	6.5	3.0
	Boar Islands: Burgeo I. lighthouse	47 35 13	57 36 52	8 22	2 10	6.2	2.9
	La Poile Bay: Gr. Espic Church	47 39 50	58 24 10	8 50	2 38	6.0	2.8
	Cape Ray: Lighthouse	47 37 00	59 18 00				
	Codroy Island: S. side Boat Harbor	47 52 30	59 23 40	8 50	2 32	4.3	2.1
	Cape St. George: Red I., SE. pt	48 33 48	59 13 10				
	Cow Head: NW. extreme	49 55 20	57 50 00	9 40	3 13	4.9	2.5
	Port Saunders: Two Hills Pt	50 38 30	57 17 07				
	Rich Point: Lighthouse	50 41 50	57 25 00				
	Férolle Pena: New Férolle Pt	51 02 00	57 03 50				
	Flower Cove: Capstan Pt	51 17 25	56 44 45				
	Green Island: 150 fms. from NE. end	51 24 10	56 33 40				
	Cape Norman: Lighthouse	51 38 00	55 53 52				
Labrador.	Chateau Bay: S. pt. Castle I	51 58 00	55 50 20				
	Amour Point: Lighthouse	51 27 35	56 51 05				
	Wood Island: S. pt	51 22 45	57 08 00				
	Greenly Island: Lighthouse	51 22 26	57 10 04				
	Bradore Bay: Obs. Spot, Jones Pt	51 27 22	57 13 21				
	Old Fort Island: Center	51 21 40	57 46 00				
	Great Mekattina Island: SE. pt	50 47 30	58 51 30				
	Mekattina Harbor: S. point of Dead Cove	50 46 44	58 59 20				
	Little Mekattina I.: S. pt. C. McKinnon	50 31 10	59 20 25				
	St. Mary Reefs	50 14 00	59 45 00				
	South Makers Ledge	50 09 30	59 57 00				
R. and G. of St. Lawrence.	Cape Whittle	50 11 00	60 08 00				
	Natashquan Point: S. edge	50 06 00	61 44 00	1 25	6 45	4.0	2.0
	Clearwater Point: SW. extreme	50 12 27	63 27 03				
	Carousel Island: Lighthouse	50 05 40	66 22 44	1 43	7 05	8.1	6.0
	Point de Monts: Lighthouse	49 19 35	67 21 55	1 48	7 18	10.8	8.0
	Quebec: Mann's Bastion, Citadel	46 48 23	71 12 19	6 07	0 54	14.6	10.8
	Quebec: Bonner's Hill Obsy	46 47 59	71 13 10				
	Montreal: St. James Cathedral	45 29 57	73 34 08				
	Ottawa: Dominion Observatory	45 23 30	75 42 59				
	Father Point: Lighthouse	48 31 25	68 27 40	1 52	7 33	12.0	8.9
	Cape Chatte: Extreme	49 06 00	66 46 00	1 46	7 13	10.5	7.8
	Cape Magdalen: Lighthouse	49 15 40	65 19 30	1 33	6 50	6.4	4.7
	Cape Rosier: Lighthouse	48 51 37	64 12 00	1 25	6 40	5.5	4.1
	Cape Gaspé: Lighthouse	48 45 15	64 09 35				
	Anticosti Island: Heath Pt. lighthouse	49 05 20	61 42 30	1 20	6 35	3.6	1.8
	SW. pt. lighthouse	49 23 45	63 35 46	1 25	6 40	4.9	2.5
New Brunswick.	Bonaventure Island: E. pt	48 29 30	64 08 00				
	Leander Shoal	48 24 00	64 18 00				
	Macquereau Point	48 12 00	64 46 30	1 55	7 33	4.7	2.3
	Chaleur Bay: Carlisle	48 01 00	65 19 00	2 20	8 07	4.8	2.4
	Dalhousie I	48 04 24	66 22 10	3 10	9 10	8.1	4.1
	Miscou Island: Birch Pt. lighthouse	48 01 07	64 29 20	2 00	8 25	4.0	2.0
	Miramichi Bay: Portage I., N. pt	47 14 00	65 02 00	4 16	10 59	2.3	1.2
	Point Escumenac: Lighthouse	47 05 00	64 47 33				
P. Edward I.	North Point: Lighthouse	47 03 46	63 58 49	4 20	11 00	2.4	1.2
	Malpeque Bay: Royalty Pt	46 33 56	63 41 35	5 15	11 55	1.8	0.9
	East Point: Lighthouse	46 27 15	61 57 35	8 17	2 20	1.4	0.7
	Charlottetown: Blackhouse Pt. light	46 11 36	63 06 58	11 07	4 23	6.4	3.2
Magdalen Is.	Gt. Bird Rock: Lighthouse	47 50 40	61 08 32				
	East Island: E. extreme	47 37 40	61 24 30				
	Entry Island: Lighthouse	47 16 30	61 41 20				
	Amherst Hbr.: N. side of entrance	47 14 23	61 49 38				
	Deadman Rock: W. pt	47 16 03	62 12 25				

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

EAST COAST OF NORTH AMERICA—Continued.

Coast.	Place.	Lat. N.	Long. W.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
	St. Paul Island: Lighthouse, NE. end....	47 13 50	60 08 32	8 30	2 12	2.7	1.4
	Lighthouse, SW. end....	47 11 20	60 09 50	....	....	....	.....
C. Breton I.	Cape North: Lighthouse................	47 01 45	60 23 27	8 35	2 17	3.1	1.6
	St. Anns Harbor: E. pt. entrance........	46 21 00	60 27 00	8 25	2 13	6.0	3.7
	Sydney Harbor: Lighthouse..............	46 12 25	60 12 50	8 10	2 05	5.0	3.1
	Scatari Island: Lighthouse, NE. pt......	46 02 15	59 40 25	....	....	....	.....
	Louisburg: Lighthouse, NE. pt..........	45 54 34	59 59 26	7 45	1 35	5.0	3.1
	Madame Island: S. pt..................	45 28 00	61 03 00	7 55	1 47	5.0	3.1
	Port Hood: Just-au-corps I..............	46 00 00	61 36 00	9 05	2 47	3.5	1.8
	Sable Island: Lighthouse, E. end.......	43 58 14	59 44 15	....	....	....	.....
Nova Scotia.	Pictou: Customhouse....................	45 40 50	62 42 10	9 34	3 13	3.9	2.0
	Cape St. George.........................	45 52 00	61 52 00	9 20	3 00	2.8	1.4
	North Canso: Lighthouse, NW. entrance.	45 41 42	61 29 10	9 26	3 10	3.1	1.6
	Arichat Harbor: R. C. Church steeple....	45 30 48	61 01 47	7 55	1 47	5.0	3.1
	Cape Canso: Cranberry I., lighthouse....	45 19 49	60 55 41	7 43	1 36	6.5	4.0
	White Head Island: Lighthouse..........	45 11 58	61 08 14	7 45	1 38	6.6	4.1
	Green Island: Lighthouse...............	45 06 15	61 32 40	....	....	....	.....
	Wedge Island: Lighthouse...............	45 00 35	61 52 45	....	....	....	.....
	Halifax: Dockyard observatory..........	44 39 38	63 35 22	7 34	1 46	5.2	3.2
	Sambro Island: Lighthouse..............	44 26 10	63 33 30	....	....	....	.....
	Margaret Bay: Shut-in I................	44 34 00	63 54 00	7 32	1 30	7.1	4.4
	Tancook Island.........................	44 29 00	64 06 00	....	....	....	.....
	Lunenburg: Battery Pt. light...........	44 21 45	64 17 35	7 39	1 36	7.0	4.3
	Cape La Have: Black Rock...............	44 12 00	64 18 00	....	....	....	.....
	Coffin Island: Lighthouse..............	44 02 00	64 37 30	....	....	....	.....
	Little Hope Island: Lighthouse..........	43 48 30	64 47 15	....	....	....	.....
	Shelburne Hbr.: Two lights, McNutts I..	43 37 15	65 15 45	....	....	....	.....
	Cape Sable: Lighthouse..................	43 23 19	65 37 11	8 17	2 05	8.5	5.2
	Seal Island: Lighthouse.................	43 23 34	66 00 52	9 35	3 23	12.8	9.5
	Yarmouth: Cape Fourchu light...........	43 47 28	66 09 21	10 00	3 41	16.0	11.8
	Cape St. Mary...........................	44 05 20	66 12 40	....	....	....	.....
	Bryer Island: Lighthouse................	44 14 57	66 23 38	10 29	4 36	20.8	15.4
	Annapolis Harbor; Prim Pt. light........	44 41 34	65 47 20	10 49	4 41	27.5	20.4
	Haute Island: Lighthouse................	45 14 55	65 00 45	11 07	5 27	33.0	24.4
	Cape Chignecto..........................	45 19 00	64 57 00	....	....	....	.....
	Burntcoat Head: Lighthouse..............	45 18 40	63 48 30	0 27	7 27	50.5	37.4
New Brunswick.	Cape Enragé: Lighthouse................	45 35 34	64 46 55	....	....	....	.....
	Cape Quaco: Lighthouse.................	45 19 30	65 32 00	11 21	5 56	30.0	22.2
	St. Johns: Partridge I. light...........	45 14 20	66 03 20	11 07	4 58	23.9	17.7
	Cape Lepreau: Lighthouse................	45 03 40	66 27 40	11 04	5 26	24.5	18.2
	L'Etang Harbor: S. pt. tower............	45 04 00	66 49 00	11 09	5 08	23.3	17.1
	St. Andrew: S. pt. light................	45 04 06	67 02 52	11 00	5 00	24.9	18.2
	Campo Bello Island: Lighthouse, N. pt..	44 57 40	66 54 10	....	....	....	.....
	Grand Manan Island: Lighthouse, NE. pt.	44 45 52	66 44 00	11 02	5 21	22.5	16.7
	Gannet Rock: Lighthouse, NE. pt.......	44 30 38	66 47 00	....	....	....	.....
	Machias Island: Lighthouse.............	44 30 07	67 06 13	10 51	4 56	18.0	13.2
Maine.	Calais: Astronomical station...........	45 11 05	67 16 50	11 36	5 40	23.3	17.1
	Eastport: Cong. Church.................	44 54 15	66 59 14	11 09	5 05	20.9	15.2
	Quoddy Head: Lighthouse................	44 48 55	66 57 04	....	....	....	.....
	Machias: Town Hall......................	44 43 01	67 27 22	11 02	4 59	15.5	11.3
	Petit Manan Island: Lighthouse..........	44 22 03	67 51 51	....	....	....	.....
	Bakers Island: Lighthouse...............	44 14 29	68 11 58	....	....	....	.....
	Mount Desert Rock: Lighthouse..........	43 58 08	68 07 44	....	....	....	.....
	Bangor: Thomas Hill.....................	44 48 23	68 46 59	0 23	6 47	15.1	11.0
	Belfast: Methodist Church..............	44 25 29	69 00 19	11 35	5 22	11.7	8.6
	Rockland: Episcopal Church.............	44 06 06	69 06 52	11 09	4 55	11.0	8.1
	Matinicus Rock: Lighthouse.............	43 47 03	68 51 28	10 45	4 31	10.2	7.5
	Monhegan Island: Lighthouse............	43 45 53	69 18 59	....	....	....	.....
	Seguin Island: Lighthouse...............	43 42 26	69 45 32	....	....	....	.....

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

EAST COAST OF NORTH AMERICA—Continued.

Coast.	Place.	Lat. N.	Long. W.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Maine.	Bath: Winter St. Church	43 54 55	69 49 00	12 13	6 16	7.9	5.8
	Brunswick: College spire	43 54 29	69 57 44	......	......	......	....
	Augusta: Baptist Church	44 18 52	69 46 37	2 54	10 18	4.9	3.6
	Portland: Customhouse	43 39 28	70 15 18	11 06	4 51	10.1	7.3
	Portland Head lighthouse	43 37 23	70 12 30	......	......	......	....
	Cape Elizabeth: Lighthouse (west)	43 33 51	70 12 11	......	......	......	....
	Wood Island: Lighthouse	43 27 24	70 19 46	11 12	4 51	10.2	7.5
	Boon Island: Lighthouse	43 07 17	70 28 37	......	......	......	....
N. H.	Whale Back: Lighthouse	43 03 32	70 41 49	......	......	......	....
	Portsmouth: Navy-yard flagstaff	43 04 56	70 44 22	11 23	5 09	10.5	7.7
	Fort Constitution	43 04 16	70 42 34	......	......	......	....
	Hampton: Baptist Church	42 56 15	70 50 12	......	......	......	....
	Isles of Shoals: White I. lighthouse	42 58 02	70 37 25	11 19	4 58	10.0	7.3
Massachusetts.	Newburyport: Academy	42 48 30	70 52 28	11 23	5 10	9.1	6.6
	Plum I. lighthouse	42 48 55	70 49 10	......	......	......	....
	Ipswich: Lighthouse (rear)	42 41 07	70 46 00	11 17	5 04	10.1	7.4
	Annisquam Harbor: Lighthouse	42 39 43	70 40 55	11 13	5 00	10.1	7.4
	Cape Ann: Thatchers I. lighthouse (N.)	42 38 21	70 34 31	......	......	......	....
	Gloucester: Universalist Church	42 36 46	70 39 59	......	......	......	....
	Ten-pound I. lighthouse	42 36 07	70 39 58	11 02	4 49	10.2	7.5
	Beverly: Hospital Pt. lighthouse	42 32 48	70 51 23	......	......	......	....
	Salem: Derbys Wharf lighthouse	42 31 00	70 53 03	11 16	5 03	10.6	7.7
	Marblehead: Lighthouse	42 30 20	70 50 03	11 09	4 57	10.6	7.7
	Cambridge: Harvard Observatory	42 22 48	71 07 46	......	......	......	....
	Boston: Navy-yard flagstaff	42 22 22	71 03 05	11 27	5 17	11.0	8.1
	State House	42 21 28	71 03 50	......	......	......	....
	Little Brewster I. lighthouse	42 19 41	70 53 26	11 09	4 56	10.9	8.0
	Minots Ledge: Lighthouse	42 16 11	70 45 35	......	......	......	....
	Plymouth: Pierhead	41 58 44	70 39 12	......	......	......	....
	Gurnet lighthouse	42 00 12	70 36 04	11 23	5 11	10.8	7.9
	Barnstable: Lighthouse	41 43 20	70 16 52	11 36	5 25	11.6	8.5
	Cape Cod: Highlands lighthouse	42 02 23	70 03 40	......	......	......	....
	Chatham: Lighthouse (south)	41 40 17	69 57 01	12 11	5 57	4.6	3.4
	Monomoy Point: Lighthouse	41 33 34	69 59 39	12 00	5 48	4.3	3.1
	Nantucket: South Church	41 16 55	70 05 57	0 04	6 00	3.8	2.3
	Nantucket Shoals: Lightship	40 37 05	69 36 33	......	......	......	....
	Sankaty Head: Lighthouse	41 17 01	69 57 57	......	......	......	....
	Tarpaulin Cove: Lighthouse	41 28 08	70 45 29	7 51	1 51	2.8	1.7
	Vineyard Haven: W. Chop lighthouse	41 26 51	70 36 01	11 34	4 33	2.0	1.2
	Gay Head: Lighthouse	41 20 55	70 50 08	7 31	1 20	3.7	2.2
	Cuttyhunk: Lighthouse	41 24 52	70 57 01	7 36	0 59	4.3	2.6
	New Bedford: Baptist Church	41 38 10	70 55 36	7 57	1 18	5.2	3.1
Rhode Island.	Sakonnet Point: Lighthouse	41 26 30	71 13 30	7 40	1 05	4.5	2.6
	Beaver Tail: Lighthouse	41 26 58	71 24 00	7 40	1 09	4.7	2.8
	Newport: Flagstaff, torpedo station	41 29 07	71 19 40	7 48	1 00	4.4	2.6
	Bristol Ferry: Lighthouse	41 38 34	71 15 39	7 53	0 40	5.2	3.6
	Providence: Brown University Obsy	41 50 21	71 23 59	8 12	0 57	5.4	3.4
	Point Judith: Lighthouse	41 21 40	71 28 55	7 32	1 17	3.8	2.3
	Block Island: Lighthouse (SE.)	41 09 10	71 33 08	7 33	1 25	3.7	2.2
	Watch Hill Point: Lighthouse	41 18 14	71 51 32	8 49	2 38	3.2	2.1
Conn. and N. Y.	Montauk Point: Lighthouse	41 04 16	71 51 27	8 20	2 03	2.3	1.5
	Stonington: Lighthouse	41 19 31	71 54 49	9 09	3 03	3.2	2.1
	New London: Groton Monument	41 21 16	72 04 47	9 26	3 32	2.9	1.9
	Little Gull Island: Lighthouse	41 12 23	72 06 26	9 26	3 04	3.0	2.0
	Gardners Island: Lighthouse, N. pt	41 08 29	72 08 44	9 40	3 35	2.5	1.7
	Plum Island: Lighthouse, W. pt	41 10 25	72 12 43	......	......	......	....
	Saybrook: Lighthouse, Lynde Pt	41 16 17	72 20 37	10 29	4 11	4.3	2.8
	New Haven: Yale University Obsy	41 19 22	72 55 09	11 08	4 54	7.0	4.9

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

EAST COAST OF NORTH AMERICA—Continued.

Coast.	Place.	Lat. N.	Long. W.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Conn. and N. Y.	Bridgeport Harbor: Lighthouse	41 09 24	73 10 49	11 09	5 04	8.4	5.9
	Norwalk Island: Lighthouse	41 02 56	73 25 11	11 03	4 56	8.2	5.7
	Shinnecock Bay: Lighthouse	40 51 03	72 30 16	7 48	1 38	3.0	2.0
	Fire Island: Lighthouse	40 37 57	73 13 08	7 19	1 20	2.2	1.4
	Albany: New Dudley Observatory	42 39 13	73 46 42	5 13	0 46	2.8	1.8
	New York: Navy-yard flagstaff	40 42 02	73 58 51	8 44	2 49	5.3	3.4
	City Hall	40 42 44	74 00 24	....	....	....	....
	Fort Wadsworth: Lighthouse	40 36 20	74 03 15	7 41	1 38	5.4	3.5
Pennsylvania, New Jersey, Delaware, Virginia, and Maryland.	Sandy Hook: Lighthouse (rear)	40 27 42	74 00 09	7 30	1 23	5.6	3.6
	Lightship	40 28 15	73 50 09	....	....	....	....
	Navesink Highlands: N. lighthouse	40 23 48	73 59 10	....	....	....	....
	Barnegat Inlet: Lighthouse	39 45 52	74 06 24	7 50	1 43	2.7	1.7
	Tuckers Beach: Lighthouse	39 30 22	74 17 08	7 48	1 42	4.2	2.7
	Absecon Inlet: Lighthouse	39 21 59	74 24 52	9 59	3 57	4.7	3.0
	Five Fathom Bank: Lightship	38 47 20	74 34 36	....	....	....	....
	Cape May: Lighthouse	38 55 59	74 57 39	8 16	1 47	5.6	3.6
	Philadelphia, Pa.: University Obsy	39 58 02	75 16 39	1 28	8 58	6.2	4.4
	Navy-yard flagstaff, League I	39 53 14	75 10 32	0 53	8 02	7.0	5.2
	Wilmington, Del.: Town Hall	39 44 27	75 33 03	12 00	6 40	6.7	4.9
	Cape Henlopen: Lighthouse	38 46 42	75 05 03	8 17	1 50	5.4	3.5
	Assateague Island: Lighthouse	37 54 40	75 21 23	....	....	....	....
	Hog Island: Lighthouse	37 23 46	75 41 59	....	....	....	....
	Cape Charles: Lighthouse	37 07 22	75 54 24	8 03	2 19	3.0	2.0
	Baltimore: Johns Hopkins Obsy	39 17 48	76 36 30	6 34	0 44	1.4	1.0
	Annapolis: Naval Academy Observatory	38 58 53	76 29 08	4 39	10 53	1.0	0.8
	Point Lookout: Lighthouse	38 02 19	76 19 20	0 31	6 52	1.7	1.1
	Washington, D. C.: Navy-yard flagstaff	38 52 30	76 59 45	7 42	1 56	3.5	2.5
	Naval Observatory	38 55 14	77 03 57	....	....	....	....
	Capitol dome	38 53 20	77 00 36	....	....	....	....
	Old Point Comfort: Lighthouse	37 00 06	76 18 24	8 44	2 17	3.0	2.0
	Norfolk: Navy-yard flagstaff	36 49 33	76 17 46	9 05	2 47	3.2	2.1
	Richmond, Va.: Capitol	37 32 16	77 26 04	4 30	11 55	4.3	2.9
	Cape Henry: Lighthouse	36 55 35	76 00 27	7 53	1 43	3.2	2.1
North Carolina.	Elizabeth City: Courthouse	36 17 58	76 13 23	....	....	....	....
	Edenton: Courthouse	36 03 24	76 36 31	....	....	....	....
	Currituck Beach: Lighthouse	36 22 36	75 49 51	7 37	1 26	3.4	2.2
	Bodie Island: Lighthouse	35 49 07	75 33 49	....	....	....	....
	Cape Hatteras: Lighthouse	35 15 17	75 31 16	....	....	....	....
	Ocracoke: Lighthouse	35 06 32	75 59 11	7 00	0 45	2.2	1.5
	Newbern: Episcopal spire	35 06 21	77 02 24	....	....	....	....
	Cape Lookout: Lighthouse	34 37 22	76 31 29	6 29	0 20	4.4	3.0
	Beaufort, N. C.: Courthouse	34 43 05	76 39 48	7 21	1 08	3.3	2.3
	Frying-Pan Shoals: Lightship	33 34 26	77 49 12	....	....	....	....
S. Carolina.	Georgetown: Episcopal Church	33 22 08	79 16 49	8 39	3 38	4.3	2.9
	Lighthouse, North I	33 13 21	79 10 55	....	....	....	....
	Cape Romain: Lighthouse	33 01 06	79 22 19	6 59	0 50	5.9	4.1
	Charleston: Lighthouse, Morris I	32 41 43	79 52 54	....	....	....	....
	St. Michael's Church	32 46 34	79 55 49	7 20	1 10	6.0	4.2
	Beaufort, S. C.: Episcopal Church	32 26 02	80 40 27	8 10	2 06	8.5	5.9
	Port Royal: Martins Industry lightship	32 05 33	80 33 15	....	....	....	....
Georgia.	Tybee Island: Lighthouse	32 01 20	80 50 37	7 10	1 04	7.9	5.5
	Savannah: Exchange spire	32 04 52	81 05 26	8 13	3 07	7.6	5.3
	Sapelo Island: Lighthouse	31 23 28	81 17 01	7 30	1 24	8.4	5.8
	Darien: Winnowing House	31 21 54	81 25 39	7 40	1 44	7.5	5.2
	St. Simon: Lighthouse	31 08 02	81 23 30	7 30	1 27	7.5	5.3
	Brunswick: Academy	31 08 51	81 29 26	8 00	1 57	7.8	5.4

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

EAST COAST OF NORTH AMERICA—Continued.

Coast.	Place.	Lat. N.	Long. W.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Florida.	Amelia Island: Lighthouse.	30 40 23	81 26 26	....	....	....	.....
	Fernandina: Astronomical station	30 40 18	81 27 47	7 39	1 31	6.9	4.8
	St. Johns River: Lighthouse	30 23 36	81 25 27	7 36	1 33	5.4	3.7
	Jacksonville: Methodist Church	30 19 43	81 39 14	....	....	....	.....
	St. Augustine: Presbyterian Church	29 53 20	81 18 41	....	....	....	.....
	Lighthouse	29 53 07	81 17 12	8 12	2 00	5.3	3.6
	Cape Canaveral: Lighthouse	28 27 37	80 32 30	8 00	1 52	5.9	4.0
	Jupiter Inlet: Lighthouse	26 56 54	80 04 48	8 00	2 00	1.8	1.2
	Fowey Rocks: Lighthouse	25 35 25	80 05 41	8 20	2 16	2.6	1.3
	Carysfort Reef: Lighthouse	25 13 17	80 12 40	8 21	2 08	2.7	1.4
	Alligator Reef: Lighthouse	24 51 02	80 37 08	8 22	2 00	2.6	1.3
	Sombrero Key: Lighthouse	24 37 36	81 06 40	8 24	2 05	1.9	1.0
	Sand Key: Lighthouse	24 27 10	81 52 40	8 40	2 20	1.5	0.8
	Key West: Lighthouse	24 32 58	81 48 04	9 20	2 36	1.6	0.9
	Loggerhead Key: Lighthouse	24 38 04	82 55 42	9 44	3 21	1.4	0.8
	Sanibel Island: Lighthouse	26 27 11	82 00 43	12 17	6 10	2.3	1.2
	Gasparilla Island: Lighthouse	26 43 06	82 15 34	0 42	6 19	1.4	0.7
	Tampa Bay: Egmont Key light	27 36 04	82 45 40	11 32	5 07	1.8	0.9
	Cedar Keys: Ast. station, Depot Key	29 07 29	83 01 57	0 42	7 13	3.1	1.5
	Seahorse Key light	29 05 49	83 03 58	....	....	....	.....
	St. Marks: Fort St. Marks	30 09 03	84 12 42	2 00	8 30	2.6	1.2
	Apalachicola: Flagstaff	29 43 32	84 59 12	[12 10]	[5 35]	[2.5]	.....
	Cape St. George: Lighthouse	29 35 18	85 02 54	....	....	....	.....
	Cape San Blas: Lighthouse	29 40 00	85 21 30	[11 10]	[4 55]	[2.1]	.....
	Pensacola: Lighthouse	30 20 47	87 18 32	....	....	....	.....
	Navy-yard chimney	30 20 49	87 16 06	[11 28]	[4 20]	[1.7]	.....
Alabama, Mississippi, and Louisiana.	Sand Island: Lighthouse (front)	30 11 19	88 03 02	....	....	....	.....
	Mobile Point: Lighthouse	30 13 44	88 01 26	[11 25]	[3 09]	[1.5]	.....
	Mobile: Episcopal Church	30 41 26	88 02 28	[1 35]	[6 50]	[2.1]	.....
	Horn Island: Lighthouse	30 13 23	88 31 39	[12 00]	[5 40]	[2.0]	.....
	East Pascagoula: Coast Survey station	30 20 42	88 32 45	[0 20]	[5 45]	[2.3]	.....
	Mississippi City: Coast Survey station	30 22 54	89 01 57	....	....	....	.....
	Ship Island: Lighthouse	30 12 53	88 57 56	....	....	....	.....
	Cat Island: Lighthouse	30 13 57	89 09 41	[0 23]	[6 35]	[2.1]	.....
	Chandeleur: Lighthouse	30 02 58	88 52 19	[11 53]	[5 33]	[1.8]	.....
	Mouth Mississippi River: Pass a l'Outre light	29 11 30	89 02 28	[11 15]	[5 00]	[1.6]	.....
	S. Pass light (East Jetty)	28 59 28	89 08 08	[10 55]	[4 42]	[1.7]	.....
	SW. Pass light.	28 58 22	89 23 30	[10 54]	[4 41]	[1.9]	.....
	New Orleans: United States Mint	29 57 46	90 03 28	....	....	....	.....
	Barataria Bay: Lighthouse	29 16 30	89 56 43	[11 00]	[4 47]	[2.1]	.....
	Timbalier Island: Lighthouse	29 02 49	90 21 25	[11 50]	[5 38]	[2.0]	.....
	Ship Shoal: Lighthouse	28 54 56	91 04 15	[0 18]	[6 33]	[2.2]	.....
	Southwest Reef: Lighthouse	29 23 36	91 30 14	[0 40]	[6 56]	[2.0]	.....
	Calcasieu Pass: Lighthouse	29 46 55	93 20 43	2 17	8 41	1.7	1.3
	Sabine Pass: Lighthouse	29 43 04	93 51 00	3 17	9 36	0.9	0.6
Texas.	Galveston: Cathedral, N. spire	29 18 17	94 47 26	[4 18]	[10 33]	[1.4]	.....
	Lighthouse, Bolivar Pt	29 22 05	94 46 00	[4 07]	[10 23]	[1.6]	.....
	Matagorda: Coast Survey station	28 41 29	95 57 26	....	....	....	.....
	Lighthouse	28 20 18	96 25 28	[4 35]	[10 47]	[1.6]	.....
	Indianola: Coast Survey station	28 32 28	96 31 01	....	....	....	.....
	Lavaca: Coast Survey station	28 37 36	96 37 21	....	....	....	.....
	Aransas Pass: Lighthouse	27 51 53	97 03 23	[4 25]	[10 35]	[1.6]	.....
	Brazos Santiago: Light, S. end Padre I	26 04 16	97 10 00	....	....	....	.....
	Point Isabel: Lighthouse	26 04 36	97 12 28	....	....	....	.....
	Rio Grande del Norte: Obsy. N. side of entrance	25 57 22	97 08 57	[1 55]	[8 03]	[1.4]	.....

MARITIME POSITIONS AND TIDAL DATA.

EAST COAST OF NORTH AMERICA—Continued.

Coast.	Place.	Lat. N.	Long. W.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Mexico.	San Fernando River: Entrance	25 23 40	97 21 25				
	Santander River: Entrance	23 46 20	97 46 55				
	Mount Mecate: Summit	22 38 40	98 04 55				
	Tampico: Lighthouse	22 15 50	97 49 55	[1 06]	[7 19]	[1.3]	
	Cape Roxo	21 35 00	97 22 00				
	Lobos Cay: Lighthouse	21 28 12	97 13 00				
	Tuxpam Reefs: Middle islet	21 03 00	97 13 35				
	Mexico: Tacubaya National Obsy	19 24 18	99 11 38				
	Bernal Chico: Middle of islet	19 39 50	96 24 39				
	Zempoala Point: Extreme	19 27 26	96 20 22				
	Vera Cruz: San Juan d'Ulloa light	19 12 30	96 07 57	[2 49]	[8 38]	[2.4]	
	Sacrificios Island	19 10 10	96 05 30				
	Orizaba Mountain: 17,400 feet	19 04 00	97 15 55				
	Cofre de Perote Mount: 14,000 feet	19 29 30	97 07 30				
	Alvarado: E. side of entrance	18 49 00	95 44 48				
	Roca Partida: Summit	18 44 00	95 11 14				
	Tuxtla, volcano: Summit	18 29 00	95 08 00				
	Montepio: Landing place	18 40 00	95 05 12				
	Zapotitlan Point: Lighthouse	18 34 00	94 50 00				
	San Juan Point: Lighthouse	18 19 45	94 38 57				
	Puerto Mexico: Lighthouse	18 08 56	94 24 47				
	Santa Ana Lagoon: Entrance	18 18 49	93 51 53				
	Tupilco River: Entrance	18 26 44	93 25 25				
	Tabasco River: Lighthouse	18 39 30	92 42 00				
	Carmen Island: NE. pt	18 47 08	91 30 50				
	Laguna de Terminos: Vigia tower, W. end Carmen I	18 38 44	91 50 17	[12 16]	[6 00]	[1.6]	
Yucatan.	Paypoton Mount: Summit	19 38 00	90 43 27				
	Lerma: Church	19 48 24	90 36 11				
	Campeche: Lighthouse	19 50 20	90 32 20	2 59	9 28	2.1	1.3
	Fort San José	19 51 36	90 30 51				
	Point Palmas	21 02 00	90 22 00				
	Sisal: Fort light	21 10 06	90 02 37	10 20	4 10	1.8	0.9
	Madagascar Reef: Center	21 26 30	90 18 27				
	Progreso: Lighthouse	21 17 00	89 39 30				
	Silan: Village	21 23 00	88 54 27				
	Lagartos: Village	21 36 30	88 10 27				
	Cape Catoche: Lighthouse	21 35 50	87 04 10	9 30	3 19	1.5	0.8
	Arcas Cays: Lighthouse	20 12 45	91 57 45	[12 06]	[5 50]	[1.6]	
	Obispo Shoal: 16-foot spot	20 29 00	92 13 27				
	New Bank: Center	20 32 00	91 52 27				
	Triangles, E. reef: Beacon	20 54 54	92 12 47	[12 00]	[5 45]	[1.6]	
	Triangles, W. reef: Cay at SW. end	20 58 00	92 18 57				
	Bajo Nuevo Reef: Center	21 50 00	92 04 26				
	Arenas Cays: NW. Cay	22 07 10	91 24 21				
	Alacran Reef: Perez Cay	22 23 36	89 41 45				
	Contoy Island: Lighthouse	21 33 00	86 48 00				
	Mugeres Island: Lighthouse	21 12 00	86 43 39	9 20	3 08	1.6	0.9
	Cancun Island: Nisuc Pt	21 03 00	86 46 45				
	Cozumel Island: N. pt. lighthouse	20 35 50	86 43 55	8 20	2 08	1.5	0.8
	S. pt. lighthouse	20 16 20	86 59 04				
	Ascension Bay: Allen Pt	19 46 55	87 28 27				
	Chinchorro Bank: Cayo Lobos light	18 23 20	87 23 40				
Belize.	Halfmoon Cay: Lighthouse	17 12 15	87 32 30				
	Mauger Cay, NW. end: Lighthouse	17 36 15	87 46 30				
	Glover Reef: SW. Cay	16 42 20	87 50 50				
	English Cay: Lighthouse	17 19 30	88 03 20				
	St. Georges Cay: Center	17 33 15	88 04 45				

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

EAST COAST OF NORTH AMERICA—Continued.

Coast.	Place.	Lat. N.	Long. W.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Belize.	Sand-Fly Cays: Hut, S. end	16 57 50	88 06 05				
	South Water Cay: Center	16 48 50	88 05 36				
	Belize: Fort George light	17 29 20	88 11 20	8 00	1 50	1.5	0.8
	North Standing Creek: Entrance	16 57 40	88 13 48				
	Sittee Point: Cay	16 47 45	88 15 15				
	Cockscomb Mount: Summit, 4,000 feet	16 48 10	88 37 40				
	Placentia Point: Huts on point	16 30 54	88 22 13				
	Icacos Point: S. extreme	16 14 15	88 35 51				
	Sarstoon River: Entrance	15 54 00	88 56 20				
Guat.	Dulce River: Entrance, W. side	15 49 45	88 46 22	9 00	2 50	2.0	1.1
	Dulce Gulf: Fort St. Philip	15 38 00	89 01 36				
	Izabal	15 24 20	89 09 15				
Honduras.	Hospital Bight: Hut, N. pt. of entrance	15 52 20	88 33 22				
	Cape Three Points: NW. extreme	15 57 45	88 38 50				
	Seal Cays: S. Cay	16 08 00	88 20 15				
	Omoa: Entrance	15 47 11	88 04 31				
	Cape Triunfo: Bluff pt.	15 48 45	87 27 46				
	Congrehoy Peak: Summit, 8,040 feet	15 38 00	86 55 00				
	Truxillo: Fort	15 55 45	85 59 18				
	Utilla Island: S. Cay	16 03 40	86 59 15				
	Hog Islands: Highest hill on W. islet	15 58 00	86 32 09				
	Roatan: Center of Coxen Cay	16 18 00	86 34 27	7 35	1 23	3.5	1.8
	Port Royal, NW. pt. of George Cay	16 24 20	86 18 41				
	Bonacca Island: Summit, 1,200 feet	16 28 00	85 55 00	8 50	2 38	1.5	0.8
	Misteriosa Bank: S. Point	18 44 00	84 02 00				
	Swan Islands: Light on W. pt. of west island	17 24 21	83 56 25				
	Great Rock Head: Bluff extreme	15 53 00	85 27 10				
	Cape Camaron	16 00 00	85 03 00				
	Brewers Lagoon: E. side of entrance	15 51 50	84 38 33				
	Patuca River: E. side of entrance	15 48 50	84 17 10				
	Carataska Lagoon: E. side of entrance	15 23 40	83 42 36				
Nicaragua.	Cape Gracias-á-Dios: Lighthouse	15 00 04	83 09 22	10 20	4 07	2.0	1.1
	Caxones Reef: Great Hobby Islet	16 03 30	83 08 20				
	Gorda Bank: Gorda Cay	15 52 00	82 23 27				
	Farrall Rock: Center	15 51 00	82 18 07				
	Halfmoon Cay: Center	15 08 50	82 42 08				
	Alargate Reef: E. pt.	15 07 00	82 20 00				
Miskito Shore.	Miskito Cays: S. end	14 21 12	82 45 57				
	Rosalind Bank: NW. extreme	16 54 00	80 51 27				
	Serranilla Bank: Beacon Cay	15 47 45	79 50 53	4 00	10 13	2.0	1.1
	Serrana Bank: Little Cay	14 21 33	80 15 20	4 00	10 13	2.0	1.1
	Quita Sueño Bank: S. extreme of reef	14 08 00	81 08 21				
	Spit at NW. end	14 30 00	81 07 21				
	Roncador Cay: S. pt.	13 34 30	80 05 05				
	Old Providence: Isabel House	13 22 54	81 21 26	4 00	10 13	1.0	0.5
	St. Andrews Island: SW. cove, Entrance I.	12 31 40	81 43 06				
	Courtown Cays: Middle Cay	12 24 00	81 27 53				
	Albuquerque Bank: Smith Cay	12 10 00	81 49 54				
	Pearl Cays: Colombilla Cay	12 22 35	83 23 10	1 50	8 03	2.0	1.1
	Pearl Cays Lagoon: Mosquito Pt.	12 20 39	83 37 12				
	Bluefields: Schooner Pt.	11 59 00	83 41 57	1 40	7 52	2.0	1.1
	Little Corn Island: Gun Pt.	12 17 30	82 58 35				
	Great Corn Island: Wells N. of Quin Bluff.	12 09 17	83 03 35	1 35	7 47	2.0	1.1
	Greytown: Lighthouse	10 56 15	83 42 15	1 00	7 13	1.5	0.8
C.R.	Mount Cartago: Peak, 11,100 feet	10 02 00	83 48 30				
	Port Limon: Monument, Park, opp. P. O.	10 00 16	83 00 57	1 00	7 13	1.6	0.9

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

EAST COAST OF NORTH AMERICA—Continued.

Coast.	Place.	Lat. N.	Long. W.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Panama.	Carreta Point: Extreme	9 38 30	82 39 06				
	Almirante Bay: Tirbi Pt., Extreme	9 26 16	82 20 40				
	Columbus I., Lime Pt	9 25 00	82 19 28				
	Shepherd I., Summit	9 14 24	82 19 36				
	Bocas del Toro, Radio Tel. Sta	9 20 17	82 14 29	0 42			
	Crawl Cay Channel: Crawl Cay	9 14 53	82 07 48				
	Blanco Peak: Summit, 11,740 feet	9 17 00	83 03 00				
	Chiriqui Lagoon: Valiente Peak, Summit.	9 10 30	81 54 06				
	Escudo de Veragua: NW. Pt. of Island	9 06 00	81 33 57				
	Chagres: San Lorenzo Castle	9 19 27	80 00 22				
	Toro Point: Lighthouse	9 22 39	79 57 13				
	Colon: Lighthouse	9 22 09	79 54 42	0 06	6 18	1.1	0.6
	Porto Bello: Ft. St. Geronimo	9 33 20	79 39 13				
	Gulf of San Blas: Cape San Blas	9 34 00	78 57 00				
	Caledonia Harbor: Dobbin Cay	8 53 52	77 40 53	11 30	5 17	1.5	0.8
	Port Carreto: Peak	8 46 30	77 32 15				
	WEST COAST OF NORTH AMERICA.						
Alaska.	Point Barrow: Highest lat. of Alaska	71 23 30	156 27 00	11 41	5 33	0.6	0.2
	Icy Cape: Extreme	70 16 00	161 47 30				
	Cape Lisburne: 849 feet	68 52 00	166 06 00				
	Cape Krusenstern: Extreme	67 09 00	163 34 00				
	Chamisso Island: Summit	66 14 30	161 45 00	7 45	1 50	2.0	0.6
	Cape Espenberg: Extreme	66 32 00	163 36 00				
	Diomede Island: Fairway Rock	65 35 30	168 40 00				
	Cape Prince of Wales: W. pt	65 33 30	168 00 00				
	Port Clarence: Point Spencer	65 16 40	166 46 30	6 10	1 10	1.1	0.9
	Cape Nome: Extreme	64 26 00	165 05 00	[2 05]	[8 25]	[2.1]	
	St. Michael: Fort	63 26 00	162 02 30	[8 05]	[1 20]	[4.5]	
	Stuart Island: W. pt	63 34 30	162 42 30				
	Cape Romanzof: Extreme	61 40 00	166 15 00				
	St. Lawrence Island: E. pt	63 16 00	168 41 00				
	St. Matthew Island: SE. pt	60 18 00	172 02 00	4 40	11 00	3.1	1.6
	Pinnacle Islet: Summit, 930 feet	60 13 00	172 36 00				
	Nunivak Island: Cape Etolin	60 25 22	166 08 30				
	Hagenmeister Island	58 48 31	160 50 00				
	Cape Menchikof: Extreme	57 30 24	157 58 30				
	Port Moller	55 54 59	160 34 54				
	St. George Island: S. side	56 34 23	169 39 50				
Aleutian Islands.			Long E.				
	Attu Island: Chichagof Harbor	52 56 01	173 12 24	3 35	9 48	5.7	2.9
	Kiska Island: Kiska Harbor, Ast. sta	51 59 04	177 30 00	3 30	9 43	5.2	2.7
	Amchitka Island: Constantine Harbor	51 23 39	179 12 06				
			Long W.				
	Adakh Island: Bay of Islands	51 49 18	176 52 00	3 25	9 38	5.0	2.6
	Atka Island: Nazan Bay (church)	52 10 36	174 15 18				
	Pribilof Island: St. Paul I., village	57 07 19	170°17 52	4 17	10 29	2.7	1.4
	Unalaska Island: C. S. station, Iliuliuk	53 52 54	166 31 44	3 50	9 58	2.9	1.5
	Sannakh Reefs: S. edge	54 13 30	162 38 00	12 13	6 10	5.7	2.8
	Sannakh Island: NE. end	54 26 12	162 18 00				
	Unga Island	55 20 45	160 38 39	2 40	8 55	8.2	4.1
	Popof Island: Humboldt I	55 19 17	160 31 14				
	Nagai Island: Sanborn Harbor	55 07 36	159 56 06				
	Koniushi Island: NW. harbor	55 03 17	159 23 05				
	NE. harbor	54 58 25	159 22 18				
	Simeonof Island: Simeonof Harbor	54 55 30	159 15 03	2 20	8 33	7.5	3.8

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

WEST COAST OF NORTH AMERICA—Continued.

Coast.	Place.	Lat. N.	Long. W.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Alaska.	Cape Strogonof: Extreme	56 48 00	158 46 00	....	....	....	.....
	Chignik Bay: Anchorage	56 19 20	158 24 24	....	....	....	.....
	Anowik Island: S. end	56 05 13	156 39 19	1 45	7 58	8.1	4.0
	Lighthouse Rocks	55 45 24	157 27 04	....	....	....	.....
	Chirikof Island	55 48 22	155 42 51	....	....	....	.....
	Kodiak Island, St. Paul Harbor: Cove NW. of village	57 47 57	152 21 21	0 16	6 24	9.0	4.5
	Port Etches	60 20 43	146 37 38	0 50	7 05	10.1	5.1
	Middleton Island	59 27 22	146 18 45	....	....	....	.....
	Mount St. Elias: Summit	60 20 45	141 00 12	....	....	....	.....
	Yakutat Bay: Port Mulgrave	59 33 42	139 46 16	0 34	6 41	9.5	5.0
	Lituya Bay	58 36 57	137 40 06	....	....	....	.....
	Sitka: Middle of parade ground	57 02 52	135 19 31	0 06	6 17	9.9	5.2
	Juneau	58 18 00	134 24 00	0 45	6 56	18.6	9.7
	Wrangell: Ast. station	56 27 00	132 23 00	0 30	6 39	17.7	9.2
Queen Charlotte Is.	North Island: N. pt	54 15 25	133 02 00	....	....	....	.....
	Cape Knox: Extreme	54 10 30	133 05 10	....	....	....	.....
	Port Kuper: Sansum I	52 56 31	132 09 06	0 00	6 12	11.5	6.1
	Forsyth Point: Extreme	52 09 07	131 03 20	....	....	....	.....
	St. James Cape: S. extreme	51 54 00	131 01 26	....	....	....	.....
	Cumshewa Harbor: N. side of entrance	53 02 00	131 31 00	....	....	....	.....
	Skidegate Bay: Rock on bar	53 22 20	131 51 00	0 07	6 19	12.8	6.7
	Rose Spit Point: Extreme	54 13 00	131 37 00	....	....	....	.....
	Masset Harbor: Masset village	54 02 14	132 11 16	....	....	....	.....
	Cape Edenshaw: Extreme	54 05 50	132 26 10	....	....	....	.....
Vancouver Island.	Hecate Bay: Observatory Islet	49 15 22	125 55 43	12 15	6 08	10.0	5.8
	Stamp Harbor: Observatory Islet	49 13 46	124 50 07	0 45	7 20	12.4	7.1
	Island Harbor: Observatory Islet	48 54 41	125 16 54	....	....	....	.....
	Cape Beale: Lighthouse	48 47 23	125 13 14	12 20	6 15	9.9	5.7
	Hesquiat Harbor: Boat Cove	49 27 31	126 24 53	12 05	5 56	10.3	5.9
	Estevan Point: S. extreme	49 22 07	126 31 58	....	....	....	.....
	Nootka Sound: Friendly Cove	49 35 31	126 36 58	12 05	5 55	9.8	5.6
	Port Langford: Colwood Islet	49 47 20	126 56 31	....	....	....	.....
	Esperanza Inlet: Observatory Rock	49 52 45	126 59 21	11 55	5 45	9.7	5.5
	Kyuquot Sound: Shingle Point	49 59 55	127 08 56	11 50	5 38	9.3	5.3
	Nasparti Inlet: Head Beach	50 11 21	127 37 24	11 47	5 34	9.3	5.3
	Cook Cape: Solander I	50 06 31	127 56 46	....	....	....	.....
	North Harbor: Observatory Rock	50 29 25	128 03 05	....	....	....	.....
	Hecate Cove: Kitten Islet	50 32 26	127 35 44	....	....	....	.....
	Cape Scott: Summit	50 46 41	128 26 11	....	....	....	.....
	Bull Harbor, Hope Island: N. pt. Indian I.	50 54 47	127 55 29	0 10	6 22	10.7	5.6
	Port Alexander: Islet in center	50 50 49	127 39 23	0 32	6 44	11.6	6.1
	Beaver Harbor: Shell Islet	50 42 36	127 24 33	0 30	6 42	11.5	6.0
	Cormorant I.: Yellow Bluff in Alert Bay.	50 35 02	126 56 56	0 55	7 08	12.8	6.7
	Baynes Sound: Beak Pt	49 36 29	124 50 44	4 45	11 00	10.6	6.6
	Nanoose Harbor: Entrance Rock	49 15 43	124 07 32	4 52	11 18	10.2	6.4
	Nanaimo: Lighthouse	49 12 50	123 48 11	....	....	....	.....
	Benson's House	49 10 15	123 56 02	4 40	11 05	9.8	6.1
	Victoria: Lighthouse	48 25 26	123 23 31	[2 17]	[8 31]	[5.7]	.....
	Esquimalt: Fisgard I. light	48 25 50	123 26 48	[2 00]	[8 14]	[5.8]	.....
	Race Island: Lighthouse	48 17 53	123 31 47	....	....	....	.....
	Port San Juan: Pinnacle Rock	48 33 30	124 27 37	....	....	....	.....
British Col.	Port Simpson: Methodist Church Spire	54 33 20	130 26 09	0 15	....	20	6.5
	Prince Rupert Hbr.: Fairview Obs. Spot	54 17 17	130 21 33	0 50	....	24, 17	16
	Port Harvey: Tide Pole Islet	50 33 58	126 16 06	1 55	8 10	14.1	7.4
	Port Neville: Robber's Nob	50 31 09	126 03 47	2 30	8 47	16.0	8.3
	Knox Bay, Thurlow Island: Stream at head of bay	50 24 15	125 38 26	3 40	10 00	15.7	7.7
	Valdes Island: S. pt	50 02 42	125 14 34	4 45	10 15	7.2	4.8
	Howe Sound: Plumper Cove	49 24 39	123 28 46	5 38	11 58	9.0	5.6

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

WEST COAST OF NORTH AMERICA—Continued.

Coast.	Place.	Lat. N.	Long. W.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
British Col.	Atkinson Point: Lighthouse	49 19 42	123 15 54	5 20	11 35	7.8	4.9
	Vancouver, Burrard Inlet: Govt. Reserve, English Bay	49 16 18	123 11 26	5 28	12 01	8.2	5.0
	Fraser River: Garry Pt	49 07 04	123 11 27	5 11	11 23	7.0	4.4
	New Westminster: Military barracks	49 13 01	123 53 52	......	......	......	......
	Point Roberts: Parallel station	49 00 00	123 04 52	......	......	......	......
	Semiamoo Bay: Parallel station	49 00 00	122 44 56	4 59	11 10	7.1	4.6
Washington.	Admiralty Head: Lighthouse	48 09 19	122 40 34	......	......	......	......
	Steilacoom: Methodist Church	47 10 20	122 35 51	4 46	11 04	11.0	7.2
	Seattle: C. S. ast. station	47 35 54	122 19 59	4 22	10 33	9.2	6.0
	Port Townsend: C. S. ast. station	48 06 56	122 44 58	3 47	9 32	6.2	4.0
	Smith Island: Lighthouse	48 19 07	122 50 36	3 40	9 28	5.6	3.7
	New Dungeness: Lighthouse	48 10 52	123 06 31	2 42	8 34	5.0	3.3
	Port Angeles: Ediz Hook lighthouse	48 08 24	123 24 07	2 10	8 23	5.3	3.4
	Cape Flattery: Lighthouse	48 23 30	124 44 06	0 08	6 16	7.1	4.1
	Cape Shoalwater: Lighthouse	46 43 00	124 04 25	......	......	......	......
	Cape Disappointment: Lighthouse	46 16 29	124 03 11	12 22	6 19	7.7	4.5
	Bremerton: Navy-yard flagstaff	47 33 43	122 37 59	4 27	10 35	9.4	6.1
	Tacoma: St. Luke's Church	47 15 32	122 26 26	4 32	10 45	9.8	6.4
Oregon.	Astoria: Flagstaff	46 11 19	123 49 42	0 15	6 42	7.8	4.7
	Yaquina Head: Lighthouse	44 40 35	124 04 40	11 50	5 37	7.3	4.3
	Cape Arago, or Gregory: Lighthouse	43 20 36	124 22 31	11 55	5 49	6.0	3.5
	Cape Blanco: Lighthouse	42 50 22	124 33 30	......	......	......	......
California.	Crescent City: Lighthouse	41 44 36	124 12 10	11 33	5 15	5.8	3.4
	Trinidad Head: Lighthouse	41 03 01	124 09 03	11 27	5 11	5.7	3.3
	Eureka: Methodist Church	40 48 11	124 09 41	11 57	5 45	5.7	3.3
	Humboldt: Lighthouse	40 41 37	124 16 26	11 33	5 19	5.3	3.1
	Cape Mendocino: Lighthouse	40 26 18	124 24 25	11 00	4 50	4.7	3.0
	Point Arena: Lighthouse	38 57 12	123 44 27	10 36	4 21	4.1	2.6
	Point Reyes: Lighthouse	37 59 39	123 01 24	11 23	5 08	5.1	3.2
	San Francisco: Davidson Observatory	37 47 28	122 25 43	12 07	5 34	5.1	3.2
	Presidio	37 47 30	122 27 49	11 43	5 07	4.9	3.1
	Berkeley Univ. Obsy	37 52 24	122 ~~51 42~~ 15 46.5	......	......	......	......
	Mare Island: Chronom. and Time Sta., Navy-yard	38 05 56	122 16 24	1 05	7 15	5.6	3.7
	Benicia: Church	38 03 05	122 09 23	1 35	7 48	5.6	3.7
	Farallon Islet: Lighthouse	37 41 51	123 00 07	10 40	4 25	4.5	2.9
	Santa Clara: Catholic Church	37 20 49	121 56 26	......	......	......	......
	Mount Hamilton: Obs. peak	37 21 03	121 36 40	......	......	......	......
	San Jose: Spire	37 19 58	121 53 39	......	......	......	......
	Pigeon Point: Lighthouse	37 10 49	122 23 39	......	......	......	......
	Santa Cruz: Warehouse flagstaff	36 57 31	122 01 29	10 54	4 27	5.2	3.3
	Monterey: C. S. azimuth station	36 35 21	121 52 59	10 43	4 24	4.8	3.1
	Point Pinos: Lighthouse	36 37 55	121 56 02	......	......	......	......
	Piedras Blancas: Lighthouse	35 39 50	121 17 06	......	......	......	......
	Point Conception: Lighthouse	34 26 49	120 28 18	......	......	......	......
	Santa Barbara: N. tower, Mission Church	34 26 10	119 42 42	9 37	3 15	4.8	2.2
	San Buenaventura: C. S. ast. station	34 15 46	119 15 56	9 53	3 21	4.9	2.2
	Pt. Fermin, San Pedro Bay: Lighthouse	33 42 14	118 17 41	9 36	3 13	5.5	2.5
	Los Angeles: Courthouse	34 03 05	118 14 32	......	......	......	......
	Point Loma: Lighthouse	32 39 48	117 14 37	9 29	3 07	5.2	2.3
	San Diego: C. S. ast. station	32 43 06	117 09 41	9 32	3 20	5.1	2.3
	Mexican Boundary: Obelisk	32 31 58	117 07 32	......	......	......	......
	San Miguel Island: Seal Pt	34 04 19	120 21 55	9 23	3 02	4.9	2.2
	Santa Rosa Island: E. pt	33 56 30	119 58 29	......	......	......	......
	Santa Cruz Island: NE. pt	34 03 12	119 33 51	9 29	3 06	4.9	2.2
	Anacapa Island: E. pt	34 00 25	119 23 04	......	......	......	......
	Santa Barbara Island: Summit	33 28 16	119 02 29	......	......	......	......
	San Nicolas Island: Summit	33 14 55	119 31 19	9 20	3 04	4.9	2.2
	Santa Catalina Island: Catalina Peak	33 23 09	118 24 05	9 28	3 08	5.1	2.3

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

WEST COAST OF NORTH AMERICA—Continued.

Coast.	Place.	Lat. N.	Long. W.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Lower California.	Ensenada Harbor: Head of bay, close to beach	31 51 10	116 38 05	9 28	3 06	5.0	2.2
	San Tomas: NW. shore of cove	31 33 04	116 40 51				
	Colnett Bay: Head of bay	30 57 39	116 17 28	9 27	3 05	5.8	2.6
	San Martin Island: Hassler Cove	30 28 58	116 06 46				
	Port San Quentin: Sextant Pt	30 22 16	115 59 07	9 23	3 00	4.9	2.2
	San Geronimo Island: Bight at E. end	29 47 20	115 48 12				
	Canoas Point: High bluff	29 25 29	115 12 14				
	Guadeloupe: North pt	29 10 50	118 18 30				
	La Playa Maria: Mound on W. side	28 56 06	114 31 06	9 15	2 53	7.6	3.4
	Santa Rosalia Bay: Obs. spot, Cairn	28 40 16	114 14 15				
	Lagoon Head: Highest pt. of crater	28 14 26	114 06 21				
	Cerros Island: SE. extremity	28 03 52	115 11 32	9 05	2 42	7.8	3.5
	San Benito Island: Summit of W. island	28 18 08	115 36 10				
	San Bartolomé: N. side of entrance	27 39 35	114 54 27	9 00	2 37	8.2	2.8
	Asuncion Island: Summit of island	27 06 10	114 17 25				
	San Ignacio Point: Extreme	26 45 45	113 16 25				
	Abreojos Point: Extreme of rocky ledge	26 42 49	113 35 04	9 00	2 48	6.7	2.3
	San Domingo Point: Edge of cliff	26 18 56	112 41 44				
	San Juanico Point: Knoll	26 03 18	112 17 52	8 29	2 17	5.7	1.6
	Alijos Rocks: South Rock	24 58 00	115 51 54				
	Cape San Lazaro: Extreme	24 47 31	112 18 25				
	Magdalena Bay: Obs. spot (post) N. of Port Magdalena	24 38 23	112 08 54	8 25	2 12	5.5	1.5
	Cape Tosco: Extreme	24 18 12	111 42 54				
	El Conejo Point: Extreme	24 20 17	111 30 21				
	Todos Santos: Foot of hill, Lobos Pt	23 27 14	110 14 07				
	San Lucas: Steep sand beach, NW. pt. of bay	22 53 07	109 54 50				
	San José del Cabo: NE. side of entrance	23 03 35	109 40 43	8 36	2 20	4.5	1.2
	Arena Point: Extreme	23 32 48	109 28 57				
	Arena de la Ventana: Extreme	24 03 52	109 50 29				
	Pichilinque Bay: SE. pt. of San Juan, Nepomezeino I	24 15 31	110 20 34				
	La Paz: Obs. spot, El Mogote	24 10 10	110 20 41	9 40	3 34	5.4	1.3
	Lupona Point: Extreme	24 24 10	110 20 35				
	San Evaristo: 3 m. S. of S. Evaristo Hd	24 52 03	110 41 47				
	San Marcial Point: Extreme	25 29 23	111 01 43				
	Salinas Bay: Beach, NE. pt. of bay	25 59 37	111 06 53				
	Loreto: Cathedral	26 00 41	111 21 03				
	Pulpito Point: Summit	26 30 44	111 27 14				
	Muleje: Equipalito Pt	26 53 37	111 58 04				
	San Marcos Island: S. sand spit	27 10 21	112 05 39				
	Santa Maria Cove: Beach on NW. shore	27 26 06	112 19 56				
	San Carlos Point: Extreme	28 00 07	112 47 36				
	Santa Teresa Bay: Beach on N. side	28 25 04	112 51 59	11 50	5 47	11.2	2.6
	Las Animas: Low pt	28 47 40	113 12 48				
	Raza Island: Landing place, S. side	28 49 11	113 00 05				
	Angeles Bay: Bight on NW. shore	28 56 39	113 34 35				
	Remedios Bay: Beach on W. shore	29 13 52	113 40 00				
	Mejia Island: S. side	29 33 08	113 35 19				
	San Luis Island: SE. side	29 57 27	114 25 49				
	San Firmin: Beach, N. of bight	30 25 16	114 39 47				
	San Felipe Point: Peak, 1,000 feet	31 02 57	114 52 10				
	Philips Point: Beacon	31 46 10	114 43 31				
Mexico.	Georges Island: NE. shore	31 00 54	113 16 30				
	Cape Tepoca: Hill, 300 feet	30 16 05	112 53 26				
	Libertad Anchorage: Beach	29 54 12	112 45 04				
	Patos Island: SE. end	29 16 12	112 28 51				
	Tiburon Island: SE. end	28 45 55	112 21 46				
	Kino Point: 0.2 mile N. 88° W. of mound	28 45 28	111 58 37				
	San Pedro: N. side of bay	28 03 22	111 16 00				
	Guaymas: Lighthouse	27 50 28	110 54 28	11 30	5 26	5.0	1.2

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

WEST COAST OF NORTH AMERICA—Continued.

Coast.	Place.	Lat. N.	Long. W.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Mexico.	Ciaris Island: NW. part	26 58 59	109 57 17	......	......	......	.....
	Santa Barbara: NW. side of bay	26 41 09	109 40 48	......	......	......	.....
	Agiabampo: SE. side of entrance	26 16 35	109 17 30	......	......	......	.....
	Topolobampo: SE. end of Santa Maria I.	25 33 56	109 10 23	......	......	......	.....
	Navachista: W. side of creek	25 23 06	108 49 00	......	......	......	.....
	Playa Colorado: N. side of entrance	25 11 42	108 23 37	......	......	......	.....
	Altata: N. side of entrance	24 38 52	107 59 37	10 07	3 59	5.8	1.4
	Mazatlan: Lighthouse	23 10 40	106 26 47	9 08	2 51	3.8	0.9
	Palenita Village: Boca Tecapan	22 30 26	105 44 25	......	......	......	.....
	San Blas: Customhouse	21 32 30	105 18 40	9 08	2 52	3.2	1.0
	Maria Madre Island: SE. extreme	21 30 45	106 33 14	......	......	......	.....
	Mita Point: Extreme	20 45 50	105 33 37	......	......	......	.....
	Peñas Anchorage: Mouth of Rio Real	20 36 26	105 16 00	......	......	......	.....
	Cape Corrientes: Extreme	20 25 00	105 39 21	......	......	......	.....
	Perula Bay: Smooth Rock	19 34 48	105 08 54	9 07	2 53	2.5	1.1
	San Benedicto Island: S. extreme	19 17 15	110 49 22	......	......	......	.....
	Socorro Island: SE. part	18 42 57	110 56 53	......	......	......	.....
	Roca Partida: Summit	18 59 41	112 04 07	......	......	......	.....
	Clarion Island: S. end	18 20 55	114 44 17	......	......	......	.....
	Clipperton Island: Summit	10 17 00	109 13 00	......	......	......	.....
	Navidad Bay: W. end of sandy beach	19 13 25	104 43 26	......	......	......	.....
	Manzanilla Bay: Flagstaff, U.S. consulate	19 03 15	104 19 50	9 07	2 54	1.9	1.3
	Sacatula River: Beach, W. side of bay	17 58 21	102 07 06	......	......	......	.....
	Isla Grande: Tripod on NW. summit	17 40 15	101 40 25	......	......	......	.....
	Sihuatanejo Point: Tree on beach	17 37 50	101 33 23	8 50	2 38	2.0	0.9
	Morro Petatlan: Junction of stony and sandy beaches	17 31 28	101 27 14	......	......	......	.....
	Tequepa Harbor: Limekiln	17 16 13	101 04 32	......	......	......	.....
	Acapulco: Lighthouse	16 49 10	99 55 50	......	......	......	.....
	Maldonado: El Recordo Pt	16 19 37	98 35 05	......	......	......	.....
	Port Angeles: Lighthouse	15 39 09	96 30 43	......	......	......	.....
	Sacrificios Point: Highest pt. of cape	15 40 41	96 15 04	......	......	......	.....
	Port Guatulco: Cross	15 44 58	96 08 10	......	......	......	.....
	Morro Ayuca: Summit of N. edge of cape	15 52 17	95 46 43	......	......	......	.....
	Salina Cruz: Lighthouse	16 09 36	95 12 16	......	......	......	.....
Central America.	Champerico: Inshore end of iron wharf	14 17 44	91 55 36	2 50	9 02	8.5	4.6
	San Jose de Guatemala: Lighthouse	13 55 15	90 49 45	2 50	9 02	9.0	4.9
	Acajutla: Lighthouse	13 34 20	89 50 26	2 55	9 08	9.5	5.1
	Libertad: Lighthouse	13 28 50	89 19 20	3 05	9 18	10.0	5.4
	La Union: Lighthouse	13 20 00	87 51 00	3 15	9 28	10.5	5.7
	Chicarene Point: Extreme	13 17 09	87 47 06	......	......	......	.....
	Corinto: Lighthouse	12 27 54	87 12 31	2 55	9 08	10.5	5.7
	San Juan del Sur: Signal station	11 14 45	85 53 00	3 00	9 12	10.0	5.4
	Salinas Bay: Salinas Islet	11 03 10	85 43 38	2 50	9 02	9.5	5.1
	Port Culebra: Extremity of Mala Pt	10 36 46	85 42 46	2 45	8 58	9.0	4.9
	Ballena Bay: N. Estero Toussa	9 43 45	85 00 46	......	......	......	.....
	Parida Anchorage: S. pt. of Deer Id	8 10 13	82 14 32	3 15	9 28	10.5	5.7
	Port Nuevo: Entrada Pt	8 04 30	81 43 30	......	......	......	.....
	Bahia Honda: W. end of Centinela I.	7 43 32	81 31 58	3 10	9 22	11.0	5.9
	Coiba (Quibo) Island: Observation pt	7 24 20	81 41 51	......	......	......	.....
	Cocos Island: Head of Chatham Bay	5 32 57	86 59 17	......	......	......	.....
	Panama: Cathedral, S. tower	8 57 06	79 32 09	3 00	9 14	16.0	8.7
	Taboga Island: Church	8 47 45	79 33 16	3 00	9 13	15.4	8.3
	Cape Mala: Extreme	7 27 40	79 59 25	3 10	9 22	13.0	7.0
	Malpelo Island: Summit	4 03 00	81 36 00	......	......	......	.....
	Point Chamé: Extreme	8 39 00	79 41 45	3 30	9 42	15.0	8.1
	Flamenco Island: N. Pt	8 54 30	79 31 15	......	......	......	.....
	Chepillo Island: Center	8 56 32	79 07 55	3 05	9 18	16.0	8.7
	Rey Island: Cocas Pt. extreme	8 12 30	78 54 40	3 00	9 13	15.7	8.5
	Darien Harbor: Graham Pt	8 28 50	78 05 35	......	......	......	.....

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

WEST INDIA ISLANDS.

Coast.	Place.	Lat. N.	Long. W.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Bahama Islands.	Memory Rock: Center	26 56 53	79 06 54	7 40	1 28	3.2	1.7
	Bahama Island: W. pt	26 41 18	79 00 38				
	Abaco Island: Lighthouse	25 51 30	77 10 45				
	Little Guana Cay: Lighthouse	26 31 10	76 57 36				
	Walker Cay: Highest part	27 15 42	78 23 48				
	Great Isaac Cay: Lighthouse	26 02 00	79 06 00				
	Gun Cay: Lighthouse	25 34 30	79 18 26	8 20	2 08	3.0	1.5
	Ginger Cay: Center	22 45 10	78 06 02				
	Cay Lobos: Lighthouse	22 22 30	77 34 26				
	St. Domingo Cay: Center	21 42 00	75 44 39				
	Cay Verde: Hill at S. end	22 01 15	75 10 34				
	Ragged Island: Gun Pt	22 14 02	75 45 17				
	Nairn Cay: E. pt	22 20 44	75 28 20				
	Nurse Channel Cay: Beacon	22 31 15	75 51 41				
	Long Island: S. pt	22 51 00	74 51 54				
	Great Exuma Island: Beacon	23 32 15	75 46 24				
	Clarence Harbor: Lighthouse	23 06 00	74 59 00	8 20	2 08	4.1	2.1
	Eleuthera Island: Lighthouse	25 00 00	76 13 00	7 00	0 48	4.0	2.1
	Royal Island: Eastern Pass	25 31 20	76 51 48				
	Nassau: Lighthouse	25 05 37	77 21 58	7 20	1 08	4.0	2.1
	Andros Island: Lighthouse	24 43 45	77 46 45	7 40	1 28	3.0	1.5
	Great Stirrup Cay: Lighthouse	25 49 40	77 53 55				
	Little Stirrup Cay: W. end	25 49 12	77 57 06				
	San Salvador (Cat I.): Lighthouse	24 06 15	74 26 00	7 00	0 48	4.0	2.1
	Concepcion Island: W. bay	23 50 50	75 07 27				
	Watlings Island: Hinchinbroke Rock	23 56 40	74 28 20				
	Rum Cay: Harbor Pt	23 37 45	74 50 08				
	Castle Island: Lighthouse	22 06 40	74 20 37				
	Fortune Island: S. end	22 32 40	74 22 54				
	Crooked Island: Moss flagstaff	22 47 30	74 20 21				
	Bird Island: Lighthouse	22 51 00	74 22 48				
	Samana Cay: W. pt	23 05 30	73 49 15				
	Plana Cay: NW. pt	22 34 38	73 38 03				
	Mariguana Island: SE. pt	22 16 30	72 47 03	7 20	1 08	3.0	1.5
	Hogsty Reef: NW. Cay	21 40 30	73 50 29				
	Inagua Island: Lighthouse	20 56 00	73 40 17	7 50	1 38	3.5	1.8
	Little Inagua Island: NW. pt	21 30 40	73 42 33				
	W. Caicos Cay: Hill, SE. end	21 37 30	72 28 18				
	French Cay: W. pt	21 30 00	72 12 51				
	Fort George Cay: Old magazine	21 54 00	72 07 14				
	Caicos Island: Parsons Pt., S. islet	21 29 33	71 31 12				
	Turk Island: Lighthouse	21 30 55	71 07 29	7 30	1 18	3.0	1.5
	Square Handkerchief Bank: NE. breaker	21 06 30	70 29 54				
	Silver Bank: E. extreme	20 35 00	69 21 24				
	Navidad Bank: Center of E. side	20 02 00	68 47 24				
Cuba.	Cape Maysi: Lighthouse	20 15 00	74 08 01	5 40	11 53	2.8	1.6
	Port Baracoa: Lighthouse	20 21 46	74 29 13				
	Port Cayo Moa: Carenero Pt	20 41 41	74 53 44				
	Nipe Bay: Extremity of Carenero Pt	20 47 19	75 34 21				
	Lucrecia Point: Lighthouse	21 04 24	75 36 59				
	Port Sama: E. side of entrance	21 09 00	75 47 18				
	Peak of Sama: Summit, 885 feet	21 07 00	75 47 40				
	Port Naranjo: E. side of entrance	21 07 30	75 52 18				
	Gibara: Lighthouse	21 07 15	76 06 27	6 20	0 08	2.4	1.4
	Port Padre: Guinchos Pt	21 18 30	76 35 34				
	Port Nuevitas: NW. corner R. R. station	21 32 44	77 15 18	7 00	0 48	2.2	1.2
	Maternillos Point: Lighthouse	21 40 02	77 08 04				
	Cay Verde: NW. end	22 08 45	77 37 33				
	Cay Confites: S. pt	22 11 14	77 39 23				
	Paredon Grande Cay: Lighthouse	22 29 10	78 09 11	7 20	1 08	2.8	1.6
	San Fernando: NW. corner Old Spanish Fort No. 1	22 09 44	78 35 54				
	Cayo Frances: Lighthouse	22 38 41	79 13 44				

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

WEST INDIA ISLANDS—Continued.

Coast.	Place.	Lat. N.	Long. W.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Cuba.	Isabella de Sagua: SE. corner of church	22 56 30	80 00 32				
	Cay Sal: Lighthouse	23 56 30	80 27 51				
	Bahia de Cadiz Cay: Lighthouse	23 12 34	80 29 26				
	Piedras Cay: Lighthouse	23 14 10	81 07 20				
	Cardenas: Cross on Cathedral	23 02 43	81 12 02				
	Matanzas: Summit of peak	23 01 54	81 43 18	8 30	2 18	2.2	1.2
	Habana: Morro lighthouse	23 09 26	82 21 29	8 18	1 56	1.3	0.7
	Transit pier, Casa Blanca Observatory	23 09 04	82 20 38				
	Flagstaff, Cabañas Fortress	23 09 11	82 21 01				
	Bahia Honda: SE. corner Morillo Fort	22 59 11	83 09 13				
	Gobernadora Pt.: Lighthouse	23 00 00	83 13 00				
	Dimas: NW. corner of warehouse	22 29 32	84 14 17				
	Cape San Antonio: Lighthouse	21 52 01	84 57 09	8 30	2.18	1.5	0.9
	Radio tower	21 53 55	84 56 16				
	La Caloma: SW. corner of warehouse	22 14 36	83 34 24				
	San Felipe Cays: SW. pt.	21 55 00	83 31 18				
	Isla de Pinos: Port Frances	21 35 30	83 09 13				
	Batabano: Lighthouse	22 41 09	82 17 42				
	Piedras Cay: Lighthouse	21 57 45	81 07 18				
	Cienfuegos: Colorados Pt. light	22 01 49	80 26 32	4 47	11 00	2.0	1.1
	Cathedral tower	22 08 36	80 27 05				
	Flagstaff, Punta Gorda	22 06 52	80 27 11				
	Casilda: Observation pier	21 48 16	79 58 58				
	Jucaro: Observation pier	21 37 24	78 51 13				
	Santa Cruz del Sur: Observation pier	20 42 23	77 59 45				
	Manzanillo: Observation pier	20 20 26	77 07 33				
	Niquero: Sugar mill, smokestack	20 02 55	77 34.50				
	Cape Cruz: Lighthouse	19 50 32	77 43 33				
	Point Mota	19 53 31					
	Chirivico: Damas Cay	19 56 57					
	Santiago: Lighthouse	19 57 29	75 52 03	8 20	2 30	2.2	1.1
	Guantanamo Bay: Fisherman Pt.	19 54 42	75 09 28	7 50	2 00	2.6	1.3
	Lighthouse	19 53 04	75 09 28				
	Naval Station flagstaff.	19 57 00	75 07 33				
	Port Escondido: Inner Entrance Pt.	19 54 08	75 03 08				
	Port Baitiqueri: Barlovento Pt.	20 01 01	74 50 49				
	Cayman Brac: E. pt.	19 45 15	79 46 07				
	Little Cayman: W. pt.	19 39 10	80 07 17				
	Grand Cayman: Fort George, W. end	19 17 45	81 23 17			[1.3]	
Jamaica.	Formigas Bank: Shoal spot	18 33 00	75 44 24				
	Morant Point: Lighthouse	17 55 05	76 11 08			[1.1]	
	Port Antonio: Folly Pt. Light	18 11 31	76 26 31				
	Port Maria: NW. wharf	18 23 00	76 54 22				
	St. Ann Bay: Long wharf	18 26 24	77 12 52			[1.2]	
	Falmouth: Fort	18 30 34	77 39 52				
	Montego Bay: Fort	18 29 25	77 56 16				
	St. Lucia: Fort	18 27 45	78 10 52				
	Savanna-la-Mar: Fort	18 12 20	78 08 54				
	Kingston: Port Royal flagstaff	17 55 56	76 50 35				
	Port Royal: Fort Charles, flagstaff	17 55 56	76 50 38			[1.1]	
	Morant Cays: NE. Cay	17 26 30	75 58 20				
	Pedro Bank: Portland Rock, E. end	17 06 20	77 26 28				
	Baxo Nuevo: Sandy Cay	15 53 00	78 39 04				
Isl. of Haiti.	Cape Engano: Extreme	18 35 52	68 18 50				
	Samana Town: Obs. spot	19 12 29	69 19 23	9 00	2 48	3.0	1.5
	Cape Cabron: East extreme	19 22 12	69 12 12				
	Port Plata: Lighthouse	19 48 51	70 41 27				
	Monte Cristi: Cabra Island	19 54 00	71 40 15				
	Manzanillo Point	19 46 20	71 46 40	6 50	0 39	5.5	2.9
	Cape Haitien: Town fountain	19 46 19	72 12 07				

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

WEST INDIA ISLANDS—Continued.

Coast.	Place.	Lat. N.	Long. W.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Island of Haiti.	Port Paix: Wharf	19 57 06	72 50 00				
	St. Nicholas Mole: Fort George, flagstaff	19 49 15	73 23 07				
	Gonaives: Verreur Pt	19 27 12	72 43 52				
	Gonave Island: W. pt	18 56 00	73 18 20				
	Arcadins Islands: Lighthouse	18 48 50	72 39 13				
	Port au Prince: Fort Islet light	18 33 31	72 21 00			[1.2]	
	Jeremie: Fort	18 39 15	74 06 52				
	Cape Dame Marie: Extreme	18 36 48	74 25 50				
	Navassa Island: NW. extreme	18 25 00	75 01 57				
	Aux Cayes: Tourterelle Bat'y	18 11 08	73 44 08				
	Jacmel: Wharf	18 13 25	72 30 45			[2.5]	
	False Cape: Extreme	17 46 08	71 41 06				
	Beata Island: NW. pt	17 36 55	71 31 10				
	Fraile Rock: Center	17 37 37	71 41 10				
	Alta Vela: Summit	17 28 22	71 38 30				
	Avarena Point: Extreme	18 08 55	71 02 25				
	Salinas Point (Caldera): Extreme	18 12 13	70 32 53				
	Sto. Domingo City: Lighthouse	18 27 54	69 52 59			[2.2]	
	Saona Island: Pt. Catuano	18 11 57	68 45 41				
Porto Rico.	Mona Island: Lighthouse	18 05 17	67 50 50				
	Mayaguez: Mouth of Mayaguez R.	18 12 37	67 09 17	7 04	2 00	2.0	1.0
	Aguadilla: Columbus Monument	18 24 51	67 09 42				
	San Juan: Morro lighthouse	18 28 23	66 07 26	8 21	2 20	1.3	0.9
	Cape San Juan: Lighthouse	18 23 01	65 37 07				
	Guanica: Meseta Pt. lighthouse	17 57 10	66 54 13			[1.0]	
	Culebrita Island: Lighthouse	18 18 56	65 13 40	[7 31]	[1 30]	[1.0]	
	Vieques (Crab) Island: Port Ferro light	18 05 54	65 25 26	[7 35]	[1 40]	[1.1]	
	St. Thomas: Fort Christian, SW. bastion	18 20 23	64 55 47	[7 11]	[0 58]	[1.2]	
	St. John Island: Ram Head	18 18 08	64 42 03				
	Tortola: Fort Burt	18 25 04	64 36 47				
	Virgin Gorda: Vixen Pt	18 30 39	64 21 48				
	Anegáda: W. pt	18 45 11	64 24 58				
	E. extreme of reefs	18 36 30	64 10 45				
	St. Croix, Christiansted: SW. bastion of fort	17 45 09	64 42 16				
	St. Croix, Lang's Observatory	17 44 43	64 41 14				
	Sombrero: Lighthouse	18 35 37	63 28 13				
	Dog Island: Center	18 16 42	63 16 00				
	Anguilla: Customhouse	18 13 06	63 04 39				
	St. Martin: Fort Marigot light	18 04 07	63 05 45				
	St. Bartholomew: Fort Oscar	17 53 58	62 51 30			[1.5]	
	Saba: Diamond Rock	17 39 10	63 15 16				
	St. Eustatius: Fort flagstaff	17 29 10	62 59 09				
	St. Christopher: Basseterre Church	17 18 12	62 43 14				
	Booby Island: Center	17 13 38	62 35 25				
	Nevis: Fort Charles	17 07 52	62 37 29				
	Barbuda: Flagstaff, Martello Tower	17 35 50	61 49 54				
	Antigua, English Harbor: Flagstaff, dockyard	17 00 00	61 46 07			[2.0]	
	Sandy Island: Lighthouse	17 06 54	61 55 11				
	Redonda Islet: Center	16 55 18	62 19 10				
	Montserrat: Plymouth Wharf	16 42 12	62 13 24				
	Guadeloupe, Basseterre: Light on mast	15 59 50	61 44 09				
	Port Louis: Light on mast	16 25 09	61 32 15				
	Gozier Islet: Lighthouse	16 11 57	61 29 40			[1.3]	
	Manroux Id.: Lighthouse	16 13 14	61 32 05				
	Point a Pitre: Jarry Mill	16 13 56	61 33 15				
	Desirade: E. pt	16 19 56	61 00 44				
	Petite Terre: Lighthouse	16 10 17	61 06 45				
	Marie Galante: Lighthouse	15 52 59	61 19 15				
	Saintes Islands: Tower on Chameau Hill	15 51 32	61 35 55				

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

WEST INDIA ISLANDS—Continued.

Coast.	Place.	Lat. N.	Long. W.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
	Dominica, Prince Ruperts Bay: Sand beach W. of church	15 34 34	61 28 14	4 00	10 12	1.5	0.8
	Roseau: Flagstaff, Fort Young	15 17 27	61 23 52	......	......	......	.....
	Aves Island: Center	15 42 00	63 37 46	......	......	......	.....
	Martinique, Fort de France: Fort St. Louis light	14 35 44	61 04 30	......	......	......	.....
	St. Pierre: Ste. Marthe Battery	14 43 54	61 11 09	......	......	......	.....
	Caravelle Pen.: Lighthouse	14 46 13	60 53 20	3 50	10 02	1.1	0.6
	Cabrit Islet: Summit	14 23 23	60 52 33	......	......	......	.....
	St. Lucia, Port Castries: Lighthouse	14 01 54	61 00 48	......	......	......	.....
	Barbados, Bridgetown: Flagstaff, Rickett's Battery	13 05 43	59 37 16	2 50	9 02	3.0	1.5
	S. Point: Lighthouse	13 02 45	59 31 50	......	......	......	.....
	Ragged Point: Lighthouse	13 09 40	59 26 04	......	......	......	.....
	St. Vincent, Kingstown: Lighthouse	13 09 19	61 14 34	2 50	9 05	1.6	0.8
	Bequia Island, Admiralty Bay: Church	13 00 25	61 14 09	......	......	......	.....
	Grenada: St. George Lighthouse	12 03 02	61 45 06	2 30	8 42	1.5	0.8
	Tobago, Rocky Bay: Lighthouse	11 10 08	60 42 38	3 50	10 02	2.1	1.1
	Testigos Islets: Center of Testigo Grande	11 25 02	63 05 48	......	......	......	.....
	Sola Island: Center	11 19 00	63 36 00	......	......	......	.....
	Pampatar, Margarita I.: San Carlos Castle	10 59 43	63 48 00	......	......	......	.....
	Tortugas Island: S. end of W. Tortugillo Islet	10 57 45	65 26 38	......	......	......	.....
	Orchila Island: S. side	11 47 57	66 12 31	......	......	......	.....
	Roques Islands: Pirate Cay	11 56 16	66 39 10	......	......	......	.....
	Bonaire Island: Lighthouse	12 02 06	68 14 10	......	......	......	.....
	Little Curaçao Island: Lighthouse	11 59 30	68 39 19	......	......	......	.....
	Curaçao Island: Fort Nassau	12 06 58	68 55 48	......	......	......	.....
	Lighthouse	12 06 15	68 56 17	......	......	......	.....
	Oruba Island: Lighthouse	12 31 05	70 02 34	......	......	......	.....

NORTH AND EAST COASTS OF SOUTH AMERICA.

Coast.	Place.	Lat. N.	Long. W.	H. W.	L. W.	Spg.	Neap.
Colombia.	Caribana Point: Extreme	8 37 30	76 52 55	......	......	......	.....
	Fuerte Island: N. extreme	9 24 00	76 10 45	......	......	......	.....
	Cispata Port: Zapote Pt	9 24 00	75 48 00	......	......	......	.....
	Cartagena: Lighthouse	10 25 50	75 32 50	......	......	......	.....
	Savanilla: Lighthouse	11 00 15	74 57 55	......	......	......	.....
	Magdalena River: NW. pt. of Gomez I	10 07 00	74 49 51	......	......	......	.....
	Santa Marta: Lighthouse	11 15 28	74 14 33	......	......	......	.....
	Rio de la Hacha: Light on church	11 33 30	72 54 50	......	......	......	.....
	Cape La Vela: Sand beach inside cape	12 12 34	72 09 42	......	......	......	.....
	Bahia Honda: E. pt., S. side	12 23 09	71 45 42	......	......	......	.....
Venezuela.	Espada Point: Extreme	12 04 00	71 07 55	......	......	......	.....
	Maracaibo: Zapara I. light	10 57 30	71 37 00	5 05	11 17	2.5	1.5
	Estangues Point: 500 ft. from extreme	11 48 56	70 17 21	......	......	......	.....
	Cape San Roman: Extreme	12 11 00	70 04 55	......	......	......	.....
	Marjes Islets: N. islet	12 29 15	70 57 00	......	......	......	.....
	Vela de Coro: Lighthouse	11 27 56	69 34 20	......	......	......	.....
	Tucacas Island: Ore house	10 47 00	68 19 55	......	......	......	.....
	St. Juan Bay: Cay	11 10 00	68 22 54	......	......	......	.....
	Puerto Cabello: Lighthouse	10 29 53	68 00 55	......	......	......	.....
	La Guaira: Lighthouse	10 36 57	66 56 06	6 00	12 12	2.8	1.7
	Cape Codera: Morro	10 35 00	66 06 15	......	......	......	.....
	Corsarios Bay: W. pt	10 34 06	66 04 13	......	......	......	.....
	Centinela Islet: Center	10 49 30	66 09 25	......	......	......	.....
	Barcelona: Morro	10 13 30	64 44 00	......	......	......	.....
	Cumana: Lighthouse	10 27 20	64 11 33	......	......	......	.....
	Escarceo Point: Extreme	10 40 00	64 17 55	......	......	......	.....
	Chacopata: Morro	10 42 00	63 50 25	......	......	......	.....

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

NORTH AND EAST COASTS OF SOUTH AMERICA—Continued.

Coast.	Place.	Lat. N.	Long. W.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Venezuela.	Esmeralda Islet: Center	10 40 00	63 31 55	....	....	....	.....
	Carupano: Lighthouse	10 40 15	63 18 00	....	....	....	.....
	Pt. Herman Vasquez	10 42 00	63 14 00	....	....	....	.....
	Puerto Santo Bay: Sand spit S. of Morro	10 43 27	63 09 43	....	....	....	.....
	Tres Puntas Cape: Extreme	10 45 00	62 41 55	....	....	....	.....
	Unare Bay: Obs. spot, 200 yds. S. of Morro	10 44 19	62 44 29	....	....	....	.....
	Pena Point: Extreme	10 43 48	61 50 50	....	....	....	.....
	Pato Island: E. pt	10 38 15	61 51 18	....	....	....	.....
	Mocomoco Pt.: Extreme	8 39 25	60 10 15	....	....	....	.....
Trinidad.	Port of Spain: King's Wharf light	10 38 37	61 30 35	4 20	10 30	3.2	1.9
	Chacachacare Island: Rocks off SW. pt.	10 40 03	61 45 54	....	....	....	.....
	Galera Point: NE. extreme, lighthouse	10 50 02	60 54 10	....	....	....	.....
	Icacos Point: Lighthouse	10 03 29	61 55 41	....	....	....	.....
	San Fernando: Pierhead	10 16 59	61 28 12	....	....	....	.....
Guiana.	Demerara: Georgetown lighthouse	6 49 20	58 11 30	4 18	9 50	8.6	3.9
	Nickerie River: Lighthouse	5 58 30	57 00 30	....	....	....	.....
	Paramaribo: Stone steps	5 49 30	55 08 48	5 50	12 00	9.5	4.3
	Maroni River: W. lighthouse	5 44 50	54 00 30	....	....	....	.....
	Salut Islands: Lighthouse	5 16 50	52 34 53	....	....	....	.....
	Enfant Perdu Islet: Lighthouse	5 02 40	52 21 11	....	....	....	.....
	Cayenne: Lighthouse	4 56 20	52 20 26	4 27	10 30	6.0	2.7
	Connetable Islet: Center	4 49 30	51 55 36	....	....	....	.....
	Carimare Mount: Summit	4 23 20	51 50 36	....	....	....	.....
Brazil.	Orange Cape: Extreme	4 20 45	51 27 46	....	....	....	.....
	Maye Mountain: Summit	2 46 30	50 54 46	....	....	....	.....
	North Cape: Extreme	1 40 17	49 56 46	....	....	....	.....
		Lat. S.					
	Cape Magoari: Extreme	0 17 00	48 23 30	....	....	....	.....
	Para: Customhouse	1 26 59	48 30 01	11 50	5 37	11.0	5.2
	Atalaia Point: Lighthouse	0 35 03	47 20 54	....	....	....	.....
	Itacolomi Point: Lighthouse	2 10 11	44 25 56	....	....	....	.....
	Maranhao Island: Landing place	2 31 48	44 18 45	6 50	0 38	16.5	7.9
	Santa Anna Island: Lighthouse	2 16 22	43 37 30	5 35	11 47	13.1	6.2
	Tutoya: Entrance	2 41 55	42 18 02	5 05	11 17	11.7	5.6
	Paranahiba River: Amarçao Village	2 53 20	41 40 35	....	....	....	.....
	Ceara: Lighthouse	3 42 05	38 28 25	5 25	11 37	8.2	3.9
	Jaguaribe River: Pilot station	4 25 35	37 44 55	5 50	12 00	8.0	3.8
	Caiçara: Village	5 03 15	36 02 52	....	....	....	.....
	Cape St. Roque: Extreme	5 29 15	35 15 52	4 05	10 17	8.8	4.2
	Rio Grande do Norte: Lighthouse	5 45 05	35 11 55	....	....	....	.....
	Natal: Cathedral	5 46 41	35 12 43	....	....	....	.....
	Parahiba River: Lighthouse at entrance	6 56 30	34 49 30	....	....	....	.....
	Parahiba: Cathedral	7 06 35	34 53 04	....	....	....	.....
	Olinda: Lighthouse	8 00 50	34 50 36	....	....	....	.....
	Pernambuco: Picao lighthouse	8 03 22	34 51 57	4 33	10 50	7.0	3.3
	Cape St. Augustine: Lighthouse	8 20 45	34 56 05	....	....	....	.....
	Tamandare: Village	8 43 40	35 05 06	....	....	....	.....
	Maceio: Lighthouse	9 39 35	35 44 54	4 20	10 32	8.5	4.1
	San Francisco River: Lighthouse at entrance	10 30 30	36 21 51	4 17	10 29	7.8	3.7
	Cotinguiba River: Lighthouse at entrance	10 58 20	37 04 00	....	....	....	.....
	Vaza Barris River: Semaphore at entrance	11 09 45	37 12 36	....	....	....	.....
	Real River: Lighthouse	11 27 40	37 24 00	....	....	....	.....
	Conde: Village	12 12 05	37 45 46	....	....	....	.....
	Garcia d'Avila: Tower	12 33 40	38 02 16	....	....	....	.....
	Bahia: Santo Antonio lighthouse	13 00 37	38 32 06	4 10	10 22	7.6	3.6
	Itaparica: Fort on N. pt	12 52 48	38 41 28	....	....	....	.....
	Morro de São Paulo: Lighthouse	13 22 37	38 54 38	3 50	10 00	6.0	2.9
	Camamu: Village	13 56 42	39 07 05	3 50	10 00	6.3	3.0
	Contas: Church	14 17 40	39 00 45	....	....	....	.....

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

NORTH AND EAST COASTS OF SOUTH AMERICA—Continued.

Coast.	Place.	Lat. S.	Long. W.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Brazil.	Ilheos: Church	14 47 40	39 03 25	3 35	9 47	6.4	3.1
	Olivença: Center of village	14 56 40	39 01 45	......	......	......	.....
	Una: Center of village	15 13 27	39 01 15	......	......	......	.....
	Comandatuba: Center of village	15 21 00	39 16 45	......	......	......	.....
	Santa Cruz: Church	16 17 20	39 02 05	3 25	9 37	6.0	2.9
	Porto Seguro: Matriz Church	16 25 38	39 04 15	......	......	......	.....
	Prado: River entrance	17 21 40	39 13 15	......	......	......	.....
	Alcobaça: Center of village	17 31 45	39 12 00	......	......	......	.....
	Caravellas: Center of village	17 43 30	39 14 36	3 10	9 23	6.4	3.1
	Abrolhos Island: Lighthouse	17 57 31	38 41 46	3 15	9 27	7.5	3.6
	Porto Alegre: Center of village	18 06 15	39 31 16	......	......	......	.....
	Espiritu Santo Bay: Lighthouse	20 19 23	40 16 36	2 50	9 00	4.0	1.9
	Guarapiri Islets: E. islet	20 38 25	40 23 46	......	......	......	.....
	Benevente: Village	20 49 00	40 40 45	2 40	8 52	5.0	2.4
	Itapemirim: Moscas Islet	20 57 35	40 46 35	......	......	......	.....
	São João da Barra: Lighthouse	21 38 40	41 02 21	......	......	......	.....
	Cape St. Thomé: Extreme	22 02 00	40 59 00	......	......	......	.....
	Macahé: Fort at entrance	22 23 45	41 47 35	2 20	8 30	9.2	4.4
	Santa Anna Island: Summit	22 26 00	41 43 15	......	......	......	.....
	Barra São João: Village	22 37 00	41 59 45	......	......	......	.....
	Busios: Church	22 46 00	41 54 05	......	......	......	.....
	Cape Frio: Lighthouse	23 00 42	42 00 00	......	......	......	.....
	Port Frio: Village	22 53 15	42 01 15	2 30	8 42	4.9	2.3
	Maricas Islands: S. islet	23 01 43	42 54 05	......	......	......	.....
	Rio de Janeiro: Fort Villegagnon Light	22 54 46	43 09 19	2 50	9 00	4.2	2.0
	National Observatory	22 54 24	43 10 21	......	......	......	.....
	Raza Island: Lighthouse	23 03 40	43 08 45	......	......	......	.....
	Petropolis: Center of town	22 32 00	43 11 01	......	......	......	.....
	Cape Guaratiba: Summit	23 03 40	43 33 24	......	......	......	.....
	Marambaya Island: Summit of SW. end	23 04 20	43 59 26	......	......	......	.....
	Mangaratiba: Village	22 57 20	44 02 29	......	......	......	.....
	Palmas Bay: Beach at head of bay	23 09 20	44 08 24	......	......	......	.....
	Angra dos Reis: Landing place	23 00 30	44 19 04	......	......	......	.....
	Ilha Grande: Lighthouse	23 09 50	44 05 45	......	......	......	.....
	Parati: Fort	23 12 20	44 42 04	1 35	7 47	5.3	2.5
	Ubatuba: Cathedral	23 25 55	45 04 04	......	......	......	.....
	Porcos Grande Islet: Summit	23 32 57	45 03 50	......	......	......	.....
	Busios Islets: Summit	23 45 15	45 00 39	......	......	......	.....
	St. Sebastian Island: Boi Pt. light	23 58 30	45 15 20	......	......	......	.....
	Villa Nova da Princessa: Center	23 47 20	45 21 04	......	......	......	.....
	Santos: Moela I. lighthouse	24 03 06	46 15 57	......	......	......	.....
	Quay	23 56 00	46 19 09	2 50	9 00	5.0	2.8
	Alcatrazes Island: Summit, 880 ft	24 06 30	45 40 49	......	......	......	.....
	Conceição: Church	24 10 32	46 47 44	......	......	......	.....
	Quemada Grande Island: Summit, 623 ft.	24 28 45	46 41 04	......	......	......	.....
	Iguape: Quay	24 42 35	47 32 54	......	......	......	.....
	Bom Abrigo Islet: Lighthouse	25 06 40	47 51 50	......	......	......	.....
	Ilha do Mel: Lighthouse	25 30 55	48 19 53	......	......	......	.....
	Paranagua; Quay	25 31 20	48 31 03	2 55	9 05	6.4	3.1
	Antonina: Quay	25 26 30	48 43 14	......	......	......	.....
	Coral Islet: Center	25 44 10	48 23 14	......	......	......	.....
	Itacolomi Islet: Center	25 50 15	48 25 51	......	......	......	.....
	São Francisco: Center of town	26 14 17	48 39 29	......	......	......	.....
	Itapacaroya: Church	26 46 45	48 36 59	......	......	......	.....
	Cambria: Church	27 01 35	48 36 44	......	......	......	.....
	Arvoredo Island: Lighthouse	27 18 00	48 22 20	......	......	......	.....
	Anhatomirim: Lighthouse	27 25 30	48 34 25	......	......	......	.....
	Sta. Catherina Island: Rapa Pt	27 22 55	48 26 09	2 35	8 47	5.9	2.8
	Naufragados light	27 50 27	48 35 16	......	......	......	.....
	Nossa Senhora do Deserto: Quay	27 36 00	48 34 14	......	......	......	.....
	Coral Island: Summit, 230 feet	27 56 40	48 33 44	......	......	......	.....
	Cape St. Martha: Lighthouse	28 38 00	48 49 45	......	......	......	.....
	Torres Point: Extreme	29 20 20	49 43 39	......	......	......	.....
	Rio Grande do Sul: Lighthouse	32 06 40	52 07 44	4 00	10 12	1.8	0.9

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

NORTH AND EAST COASTS OF SOUTH AMERICA—Continued.

Coast.	Place.	Lat. S.	Long. W.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Uruguay.	Castillos: Beuna Vista Hill, 184 feet	34 21 19	53 47 16	8 20	2 08	2.0	0.9
	Cape Santa Maria: Lighthouse	34 40 01	54 09 14	....	....	....	....
	Lobos Island: Center	35 01 39	54 53 16	....	....	....	....
	Maldonado: Lighthouse	34 58 15	54 57 10	....	....	....	....
	Flores Island: Lighthouse	34 56 55	55 55 04	....	....	....	....
	Montevideo: Cathedral, SE. tower	34 54 33	56 12 15	2 00	8 12	3.5	2.3
	Colonia: Lighthouse	34 28 20	57 52 27	6 30	0 00	4.0	2.7
Argentina.	Martin Garcia Island: Lighthouse	34 10 50	58 15 40	....	....	....	....
	Buenos Ayres: Cupola of customhouse	34 36 30	58 22 14	6 43	12 15	2.1	1.4
	La Plata: National University Obsy	34 54 30	57 54 15	....	....	....	....
	Indio Point: Lighthouse	35 15 45	57 10 45	....	....	....	....
	Piedras Point: Extreme	35 26 50	57 05 28	....	....	....	....
	Cape San Antonio: Lighthouse	36 18 24	56 44 15	9 50	3 35	5.3	3.5
	Madanas Point: Lighthouse	36 53 00	56 38 54	....	....	....	....
	Cape Corrientes: E. summit	38 05 30	57 30 01	....	....	....	....
	Port Belgrano: Anchor-Stock Hill	38 57 00	61 59 15	6 00	0 00	15.8	8.2
	Argentina: Fort	38 43 50	62 15 27	....	....	....	....
	Labyrinth Head: Summit	39 26 30	62 03 22	....	....	....	....
	Union Bay: Indian Head	39 57 30	62 07 46	....	....	....	....
	San Blas Harbor: SW. end of Hog Islet	40 32 52	62 09 30	....	....	....	....
	San Blas Bay: Summit of Rubia Pt	40 36 10	62 10 12	....	....	....	....
	Rio Negro: Main Pt	41 02 00	62 45 11	10 50	4 38	14.7	7.7
	Bermeja Head: E. summit	41 11 00	63 08 16	....	....	....	....
	Port San Antonio: Point Villarino	40 49 00	64 54 41	10 35	4 23	23.5	12.3
	San Antonio Sierra: Summit	41 41 10	65 12 29	....	....	....	....
	Port San Jose: San Quiroga Pt	42 14 15	64 27 56	....	....	....	....
	Delgado Point: SE. cliff	42 46 15	63 37 16	....	....	....	....
	Cracker Bay: Anchorage	42 57 00	64 28 20	....	....	....	....
	Port Madryn: Anchorage off cave bluff	42 45 40	64 59 00	7 05	0 52	13.2	6.9
	Chupat River: Entrance	43 20 45	65 03 36	....	....	....	....
	Port St. Elena: St. Elena pen	44 30 40	65 22 10	3 50	10 03	16.8	8.8
	Leones Island: SE. summit	45 04 00	65 36 01	....	....	....	....
	Melo Port: W. pt	45 03 00	65 52 30	....	....	....	....
	Port Malaspina: S. pt	45 10 10	66 32 36	....	....	....	....
	Cape Three Points: NE. pitch	47 06 20	65 51 46	....	....	....	....
	Port Desire: Largest ruin	47 45 05	65 54 45	0 00	6 12	18.3	9.6
	Sea Bear Bay: Wells Pt	47 57 15	65 45 40	....	....	....	....
	Port San Julian: Sholl Pt	49 15 20	67 42 30	10 35	4 23	29.5	15.4
	Port Santa Cruz: Mount at entrance	50 08 30	68 23 00	9 20	3 08	39.6	20.7
	Coy Inlet: Height S. side of entrance	50 58 27	69 09 47	9 00	2 47	40.0	20.9
	Gallegos River: Observation mound	51 33 21	69 00 31	8 40	2 28	45.6	23.9
	Cape Virgins: SE. extreme	52 18 35	68 22 12	8 18	2 06	38.7	20.2
	Cape San Diego: Extreme	54 40 35	65 05 53	4 20	10 33	9.9	5.2
	Staten Island, Cape St. John: Lighthouse, W. pt	54 43 24	63 47 00	4 19	10 32	7.8	6.0
	Port Cork: Observation mark, summit	54 45 16	64 03 00	....	....	....	....
	Cape St. Bartholomew: Middle pt	54 53 45	64 45 45	....	....	....	....
	Good Success Bay: S. end of beach	54 48 02	65 13 48	....	....	....	....
Chile.	Lennox Cove: Bluff, N. end of beach	55 17 00	66 49 00	....	....	....	....
	Goree Road: Guanaco Pt	55 19 00	67 10 00	3 50	10 03	6.7	5.2
	Wollaston Island: Middle Cove	55 35 30	67 19 00	....	....	....	....
	Barneveldt Islands: Center	55 48 54	66 43 48	....	....	....	....
	Cape Horn: South summit, 500 ft	55 58 41	67 16 15	....	....	....	....
	Hermite Island: St. Martin Cove	55 51 20	67 34 00	4 07	10 02	4.8	3.8
	False Cape Horn: S. extreme	55 43 15	68 04 40	....	....	....	....
	Ildefonso Islands: Highest summit	55 52 30	69 17 30	....	....	....	....
	Diego Ramirez Island: Highest summit	56 28 50	68 41 30	3 50	10 03	5.0	3.9
	York Minster Rock: Summit, 800 ft	55 24 50	70 01 30	....	....	....	....
	Cape Desolation: S. summit	54 45 40	71 36 10	....	....	....	....
	Mount Skyring: Summit, 3,000 ft	54 24 48	72 10 20	....	....	....	....

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

WEST COAST OF SOUTH AMERICA.

Coast.	Place.	Lat. S.	Long. W.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Chile.	Noir Island: SE. extreme	54 30 00	73 00 00	2 20	8 33	4.8	3.7
	Landfall Island: Summit of Cape Inman	53 18 30	74 18 15	1 50	8 03	4.7	3.7
	Cape Deseado: Peaked summit	52 55 30	74 36 30				
	Apostle Rocks: W. rocks	52 46 15	74 46 50				
	Cape Pillar: N. cliff	52 42 50	74 42 20	0.32	6 45	4.0	3.1
	Dungeness Point: Lighthouse	52 23 55	68 25 45	8 19	2 07	39.4	20.6
	Cape Espiritu Santo: NE. cliff	52 39 00	68 34 00	8 20	2 08	39.0	20.4
	Catharine Point: NE. extreme	52 32 00	68 45 20	8 24	2 12	30.0	15.7
	Cape Possession: Lighthouse	52 17 54	68 57 10	8 35	2 25	39.0	20.4
	Cape Orange: N. extreme	52 28 40	69 24 00				
	Delgada Point: Lighthouse	52 28 00	69 33 00	8 47	2 40	39.0	20.4
	Cape Gregory: Lighthouse	52 38 18	70 14 16	9 23	3 20	21.0	11.0
	Cape St. Vincent: W. extreme	52 46 20	70 25 25				
	Elizabeth Island: NE. bluff	52 49 18	70 37 51	10 24	4 24	8.0	4.2
	Sandy Point: Lighthouse	53 10 10	70 54 24	11 03	5 03	5.0	2.6
	Cape St. Valentine: Summit, at extreme	53 33 30	70 34 27				
	Port Famine: Observatory	53 38 12	70 58 31	11 58	5 58	6.0	3.1
	Cape San Isidro: Extreme	53 47 00	70 55 03	12 21	6 21	8.0	4.2
	Cape Froward: Summit of bluff	53 53 43	71 17 15	0 28	6 53	7.0	3.7
	Mount Pond: Summit	53 51 45	71 55 30				
	Port Gallant: Wigwam Pt	53 41 45	71 59 41	1 20	7 40	8.0	4.2
	Charles Island: White rock near NW. end	53 43 57	72 04 45				
	Rupert Island: Summit	53 42 00	72 10 42				
	Mussel Bay: Entrance	53 37 10	72 19 30				
	Tilly Bay: Sarah I	53 34 20	72 27 10				
	Borja Bay: Bluff on W. shore	53 31 45	72 34 15	1 54	8 11	5.5	2.9
	Cape Quod: Extreme	53 32 10	72 32 25				
	Barcelo Bay: Entrance	53 30 50	72 38 00				
	Swallow Bay: Shag I	53 30 05	72 47 30	1 53	8 08	5.0	3.9
	Cape Notch: Extreme	53 25 00	72 47 55				
	Playa Parda Cove: Summit of Shelter I	53 18 45	73 00 30	1 31	7 44	4.5	3.5
	Pollard Cove: Entrance	53 15 30	73 12 05				
	Port Angosto: Hay Pt	53 13 40	73 21 30	1 09	7 21	4.0	3.1
	St. Anne Island: Central summit	53 06 30	73 15 30				
	Half Port Bay: Point	53 11 40	73 17 45				
	Upright Port: Entrance	53 06 35	73 16 15				
	Port Tamar: Mouat Islet	52 55 46	73 44 28	0.55	7 07	6.0	4.6
	Port Churruca: Summit of Blanca Pen	53 01 00	73 59 33				
	Valentine Harbor: Observation mount	52 55 00	74 17 45				
	Cape Parker: W. summit	52 42 00	74 13 30				
	Mercy Harbor: Summit of Battle I	52 44 58	74 38 14				
	Mayne Harbor: Observation spot	51 18 29	74 04 00				
	Port Grappler: Observation spot	49 25 19	74 17 39				
	Port Riofrio: Vitalia I	49 12 40	74 23 27				
	Eden Harbor: Observation spot	49 07 30	74 25 10				
	Halt Bay: Observation islet	48 54 20	74 20 55				
	Westminster Hall Islet: E. summit	52 37 18	74 23 10				
	Evangelistas Island: Lighthouse	52 24 00	75 06 00	0 55	7 08	4.4	3.4
	Cape Victory: Extreme	52 16 10	74 55 00				
	Cape Isabel: W. extreme	51 51 50	75 13 20				
	Cape Santiago: Summit	50 42 00	75 27 45				
	Molyneux Sound: Romalo I	50 17 20	74 51 30				
	Cape Tres Puntas: Summit, 2,000 ft	50 02 00	75 22 00				
	Port Henry: Observation spot	50 00 18	75 13 20	0.30	6 45	4.5	3.5
	Mount Corso: SW. summit	49 48 00	75 34 00				
	Rock of Dundee: Summit	48 06 15	75 40 30				
	Santa Barbara Port: N. extreme obs. pt	48 02 20	75 28 20	0 15	6.30	5.3	4.1
	Guaineco Islands: Speedwell Bay, hill, NE. pt	47 39 30	75 10 00				
	Port Otway: Observation spot	46 49 31	75 18 20	0 10	6 25	5.3	4.1
	Cape Tres Montes: Extreme	46 58 57	75 25 30				
	Cape Raper: Rock close to cape	46 49 10	75 37 55				
	Christmas Cove: SE. extreme	46 35 00	75 31 30				
	Hellyer Rocks: Middle	46 04 00	75 12 00				

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

WEST COAST OF SOUTH AMERICA—Continued.

Coast.	Place.	Lat. S.	Long. W.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Chile.	Cape Taytao: W. extreme	45 53 20	75 06 00	0 00	6 13	4.4	3.4
	Socorro Island: S. extreme	44 55 50	75 08 45				
	Mayne Mountain: Summit, 2,080 ft	44 09 00	74 07 45				
	Port Low: Huacanec I., S. end	43 49 15	74 00 30	0 15	6 10		
	Guafo Island: S. extreme	43 43 05	74 42 15	12 10	6 00	6.1	3.1
	Port San Pedro: Cove on S. shore	43 19 30	73 42 25				
	Cape Quilan: SW. extreme	43 16 25	74 24 15				
	Corcovado Volcano: Summit, 7,527 ft	43 11 30	72 48 30				
	Minchinmadiva Volcano: S. summit, 8,000 feet	42 46 45	72 31 25				
	Castro: Extreme of point	42 29 15	73 45 05	0 01	6 21	18.0	9.1
	Dalcahue: Chapel	42 22 45	73 38 10				
	Comau Inlet: Morro Comau	42 11 15	72 35 55				
	Port Montt: Lt. on end of pier	41 28 36	72 56 15	0 31		21.0	14.5
	Port Calbuco: La Picuta	41 46 20	73 07 55	1 10	7 35	14.8	7.5
	Ancud: Ahui Pt. light	41 49 58	73 51 12	0 04	6 20	5.9	3.0
	Condor Cove: Landing	40 46 19	73 51 00				
	Ranu Cove: Anchorage	40 43 18	73 49 50				
	Muilcalpue Cove: Landing place	40 35 52	73 45 00				
	Milagro Cove: Landing place	40 21 04	73 45 20				
	Laruehuapi Cove: Landing place	40 11 47	73 41 50	0 00	6 13	7.2	3.7
	Valdivia: Niebla Fort light	39 51 37	73 26 25	10 25	4 13	5.6	2.8
	Queule Bay: Choros Pt	39 23 00	73 14 00	10 18	4 05	4.9	2.5
	Mocha Island: Lighthouse	38 21 22	73 58 06	10 20	5 07	3.3	1.7
	Lebu River: Tucapel Head	37 35 20	73 39 55	10 15	4 02	4.9	2.5
	Yañez Port: Anchorage	37 22 30	73 40 00	10 10	3 55	5.3	2.7
	Lota: Lighthouse	37 05 20	73 11 13	10 05	3 50	4.9	2.5
	Santa Maria Island: Lighthouse	36 59 07	73 32 30	10 10	3 55	6.0	3.0
	Talcahuano: Fort Galvez	36 42 00	73 07 27	10 04	3 51	5.3	2.7
	Light on Quinquina I	36 36 45	73 02 49	10 05	3 53	5.0	2.5
	Llico: Village	34 46 02	72 06 12	9 57	3 48	4.1	2.1
	Port San Antonio: Village	33 34 13	71 38 00	9 44	3 34	4.0	2.0
	Aconcagua Mountain: Summit	33 38 30	69 56 30				
	Santiago: Observatory	33 26 42	70 41 32				
	Valparaiso: Playa Ancha Pt. light	33 01 08	71 38 52	9 37	3 26	3.9	2.0
	Site of old Fort San Antonio	33 01 52	71 38 42				
	Quintero Point: Summit	32 46 00	71 32 56	9 35	3 25	4.1	2.1
	Pichidangui: SE. pt. of island	32 07 55	71 33 22	9 30	3 20	3.9	2.0
	Tablas Point: SW. extreme	31 51 45	71 34 51	9 26	3 16	4.2	2.1
	Chuapa River: S. entrance pt	31 39 30	71 35 20				
	Maitencillo Cove: N. head	31 17 05	71 39 21				
	Talinay Mount: Summit	30 50 45	71 39 00				
	Lengua de Vaca: Lighthouse	30 14 00	71 39 00				
	Port Tongoi: Obs. spot. W. of village	30 15 14	71 31 09	9 15	3 05	4.1	2.1
	Coquimbo: Tortuga Pt. light	29 56 15	71 21 00	8 58	2 48	4.9	2.5
	Smelting works, N. of town	29 56 24	71 21 53				
	N. islet	29 55 10	71 22 21				
	Pajaros Islets: Lighthouse	29 34 40	71 33 20				
	Choros Islands: SW. pt. of largest island	29 15 45	71 34 38				
	Chañaral Island: Lighthouse	29 00 50	71 36 40				
	Huasco: Light on mole	28 27 20	71 15 45	8 23	2 10	4.9	2.5
	Herradura de Carrizal: Landing place	28 05 45	71 12 48	8 50	2 38	4.9	2.5
	Port Carrizal: Middle Point	28 04 30	71 11 32				
	Matamoras Cove: Outer pt. S. side	27 54 10	71 09 38				
	Salado Bay: Summit of Cachos Pt	27 39 20	71 03 26				
	Copiapo: Landing place	27 20 00	70 58 45	8 21	2 08	5.0	2.5
	Caldera: Lighthouse	27 03 15	70 52 54	8 50	2 37	4.9	2.5
	Light on mole head	27 03 15	70 53 45				
	Cabeza de Vaca Point: Extreme	26 51 05	70 51 55				
	Flamenco: SE. corner of bay	26 34 30	70 44 25	9 00	2 47	5.0	2.5
	Chañaral Bay: Observation pt	26 20 00	70 37 25	9 05	2 52	4.9	2.5
	St. Felix I.: Peterborough Cathedral Rock	26 16 12	80 11 43				
	Pan de Azucar Island: Summit	26 09 15	70 43 57				

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

WEST COAST OF SOUTH AMERICA—Continued.

Coast.	Place.	Lat. S.	Long. W.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Chile.	Lavata: Cove near SW. pt	25 39 30	70 44 03	9 10	2 57	5.0	2.5
	San Pedro Point: Summit	25 31 00	70 41 18				
	Port Taltal: Lighthouse	25 25 20	70 34 10	9 20	3 07	4.9	2.5
	Grande Point: Outer summit	25 07 00	70 30 16	9 35	3 22	5.0	2.5
	Paposo Road: Huanillo Pt	25 05 25	70 29 50	9 30	3 17	4.9	2.5
	Reyes Head: Extreme pitch	24 34 30	70 36 29				
	Cobre Bay: Pt. W. of village	24 15 00	70 33 00				
	Jara Head: Summit	23 53 00	70 32 28				
	Antofagasta: Lighthouse	23 38 50	70 25 18	9 05	2 52	4.7	2.4
	Chimba Bay: E. pt. of large island	23 33 05	70 26 55				
	Moreno Mountain: Summit	23 28 30	70 34 56				
	Constitution Cove: Shingle pt. of island	23 26 42	70 37 11				
	Mexillones Mount: Summit	23 06 30	70 31 39	9 35	3 22	3.9	2.0
	Port Cobija: Landing place	22 34 00	70 17 42	9 44	3 31	4.0	2.0
	Tocopilla: Extremity Point	22 06 00	70 13 40	8 55	2 42	4.8	2.4
	San Francisco Head: W. pitch	21 55 50	70 11 17				
	Loa River: Mouth	21 28 00	70 02 45				
	Lobos Point: Outward pitch	21 05 30	70 12 12	9 00	2 47	4.9	2.5
	Pabellon de Pica: Summit	20 57 40	70 10 26				
	Patache Point: Extreme	20 51 05	70 14 40				
	Iquique: Lighthouse	20 12 30	70 11 20	8 35	2 22	5.0	2.5
	Mexillon Bay: Landing place	19 05 01	70 10 30				
	Pisagua: Pichalo Pt. extreme	19 36 30	70 15 21	8 32	2 20	5.0	2.5
	Gorda Point: W. low extreme	19 19 00	70 17 50				
	Lobos Point: Summit	18 45 40	70 21 50				
	Arica: Iron church	18 28 43	70 20 00	7 49	1 37	5.6	2.8
	Schama Mount: Highest summit	17 58 35	70 52 31				
Peru.	Coles Point: Extreme	17 42 00	71 22 31				
	Ilo: Mouth of rivulet	17 37 00	71 20 01	7 55	1 43	5.3	2.7
	Port Mollendo: Lighthouse	17 01 00	72 02 53				
	Islay: Customhouse	17 00 00	72 07 16	7 39	1 27	6.2	3.1
	Quilca: W. head of cove	16 42 20	72 27 16				
	Pescadores Point: SW. extreme	16 23 50	73 16 41				
	Atico: E. cove	16 13 30	73 41 31				
	Chala Point: Extreme	15 48 00	74 27 16				
	Lomas: Flagstaff on pt	15 33 15	74 51 01				
	San Juan Port: Needle Hammock	15 20 56	75 09 36	6 47	0 35	3.9	2.0
	Nasca Point: Summit	14 57 00	75 30 46				
	Mesa de Doña Maria: Central summit	14 41 00	75 49 56				
	Carreta Mount: Summit	14 09 50	76 16 36				
	San Gullan Island: N. summit	13 50 00	76 27 31				
	Paraca Bay: N. extreme of W. pt	13 48 00	76 18 31				
	Pisco: Lighthouse	13 45 00	76 10 00	6 16	0 04	3.8	1.9
	Chincha Islands: Boat slip, E. side N. id	13 38 20	76 24 15				
	Frayles Point: Extreme	13 01 00	76 31 06				
	Asia Rock: Summit	12 48 00	76 38 11				
	Chilca Point: SW. pitch	12 31 00	76 48 56				
	Morro Solar: Summit	12 11 30	77 02 31				
	San Lorenzo Island: Lighthouse	12 04 03	77 15 44				
	Callao: Palominos Rock Light	12 08 15	77 14 45	5 47	12 00	3.5	1.8
	Pescadores Islands: Summit of largest	11 47 10	77 16 11				
	Pelado Island: Summit	11 27 10	77 50 04				
	Supé: W. end of village	10 49 45	77 43 42				
	Huarmey: W. end of sandy beach	10 06 15	78 10 02	5 08	11 21	2.1	1.1
	Colina Redonda: Summit	9 38 35	78 21 33				
	Samanco Bay: Cross Pt	9 15 30	78 30 03				
	Chimbote: Village, N. part	9 04 40	78 35 57	4 50	11 03	2.0	1.0
	Chao Islet: Center	8 46 30	78 45 16				
	Guanape Islands: Summit of highest	8 34 50	78 56 53				
	Huanchaco Point: SW. extreme	8 05 40	79 06 46				
	Malabrigo Bay: Rocks	7 42 40	79 26 00	4 19	10 32	2.1	1.1
	Pacasmayo: Lighthouse	7 23 40	79 33 15				

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

WEST COAST OF SOUTH AMERICA—Continued.

Coast.	Place.	Lat. S.	Long. W.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Peru.	Eten Head: Lighthouse	6 55 50	79 51 30	4 04	10 17	2.5	1.3
	Lambayeque: Beach opposite	6 46 00	79 57 55				
	Lobos de Afuera Island: Cove on E. side	6 46 45	80 42 54				
	Lobos de Tierra Island: Central summit	6 26 45	80 51 56				
	Aguja Point: W. cliff summit	5 55 30	81 09 19				
	Paita Cathedral	5 05 02	81 07 17				
	Parinas Point: Extreme	4 40 50	81 17 01				
	Cape Blanco: Under middle of high cliff	4 16 40	81 12 01				
	Tumbez: Malpelo Pt	3 30 42	80 28 12				
Ecuador.	Guayaquil River: Light on Santa Clara I.	3 10 40	80 25 29	4 00	10 13	10.0	5.1
	Guayaquil, Concejo: S. pt. of city	2 12 24	79 52 19	7 00	1 00	11.0	5.6
	Puna: Mandinga Pt. light	2 44 30	79 53 45				
	Point Santa Elena: Veintemilla light	2 12 00	80 59 00	3 00	9 13	7.9	4.0
	Plata Isle: E. pt	1 16 55	81 03 55				
	Cape San Lorenzo: Marlinspike Rock	1 03 30	80 55 55				
	Manta Bay: Lighthouse	0 56 50	80 42 50	3 10	9 23	7.5	3.8
	Caraques Bay: Punta Playa	0 35 25	80 25 24				
	Cape Pasado: Extreme	0 21 30	80 30 37	3 15	9 28	9.9	5.0
		Lat N.					
	Point Galera: N. extreme	0 50 10	80 05 40				
	Cape San Francisco: SW. extreme	0 40 00	80 07 55				
Colombia.	Esmeralda River: Lighthouse	1 03 30	79 42 00				
	Mangles Point: S. pt. of creek entrance	1 36 00	79 03 30				
	Tumaco: S. pt. of El Morro I.	1 49 36	78 45 29	3 35	9 48	13.2	7.1
	Guascama Point: Extreme	2 37 10	78 24 24				
	Gorgona Island: Watering Bay	2 58 10	78 11 16				
	Buenaventura: Basin Pt	3 49 27	77 11 45	6 00	12 13	13.2	7.1
	Chirambiri Point: N. extreme	4 17 06	77 29 44				
	Cape Corrientes: SW. extreme	5 28 46	77 33 28	3 40	9 53	13.1	7.0
	Cupica Bay: Entrance to Cupica River	6 41 19	77 30 31	3 30	9 43	13.3	7.2
	Cape Marzo: SE. extreme	6 49 45	77 40 55				

ISLANDS IN THE ATLANTIC OCEAN.

	Færoe Islands, Strom Islet: Thorshaven Fort flagstaff	62 02 26	6 43 08				
	Halderoig Islet: Halderoig Church	62 18 20	7 00 36				
	Numken Rock	61 23 00	6 45 30				
	Rockall Islet: Summit, 70 feet	57 35 52	13 42 21				
Azores Islands.	Corvo Island: S. pt	39 40 07	31 08 00				
	Flores Island: Santa Cruz Fort	39 27 00	31 08 49				
	Fayal Channel: N. Magdalen Rock	38 32 09	28 34 00				
	Fayal Island, Horta: Castle of Santa Cruz	38 31 45	28 37 39	11 30	5 18	3.9	1.8
	Caldera: Summit 3,351 ft.	38 34 30	28 44 00				
	Pico Island: Summit	38 25 00	28 28 12				
	St. George Island: Lighthouse	38 40 30	28 13 00				
	Graciosa Island: Santo Fort light	39 05 24	28 00 45				
	Terceira Island: Monte del Brazil, near Angra	38 38 20	27 13 45	0 20	6 32	4.4	2.0
	St. Michael Island: Customhouse, Ponta Delgada	37 44 16	25 40 40				
	Pt. Arnel light	37 49 20	25 08 21	0 15	6 27	5.7	2.6
	Santa Maria Island: Villa do Porto light	36 56 00	25 10 00				
	Formigas Islands: Highest rock	37 16 44	24 47 06				

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

ISLANDS IN THE ATLANTIC OCEAN—Continued.

Coast.	Place.	Lat. N.	Long. W.	Lun. Int. H. W.	Lun. Int. L. W.	Range Spg.	Range Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Madeira Is.	Porto Santo Island: Lighthouse	33 03 15	16 16 20	0 40	6 52	6.6	3.0
	Desertas: Chao I., Sail Rock	32 35 45	16 33 30				
	Madeira Island: Funchal light	32 37 43	16 54 53	0 35	6 47	6.6	3.0
	Fora I. lighthouse	32 43 14	16 39 31				
	Pico Ruivo, summit, 6,056 ft	32 45 00	16 57 30				
	Pargo (W.) Pt	32 48 07	17 16 05				
	Salvage Islands: Lighthouse, Gran Salvage I	30 08 00	15 54 00				
Canary Islands.	Alegranza Island: Delgada Pt. light	29 23 50	13 29 31				
	Lanzarote Island: Port Naos light	28 57 24	13 33 07	0 50	7 00	8.5	3.9
	Pechinguera Pt. light	28 50 56	13 52 05				
	Lobos Island: Martino Pt. light	28 45 25	13 49 13				
	Fuerta Ventura Island: Jandia Pt. light	28 03 00	14 31 35				
	Gran Canaria: Isleta Pt. light	28 10 42	15 25 11	0 40	6 50	9.3	4.3
	Palmas light	28 07 06	15 24 56				
	Teneriffe Island: Anga Pt. light	28 35 25	16 08 11				
	Santa Cruz, Br. consulate	28 28 12	16 15 09	1 15	7 27	7.8	3.6
	Summit of peak, 12,180 ft	28 16 35	16 38 02				
	Gomera Island: Port Gomera	28 08 00	17 05 55				
	Ferro Island: Port Hierro	27 46 30	17 54 22				
	Palma Island: Light, NE. pt	28 50 06	17 47 01	0 20	6 30	8.6	4.0
Cape Verde Islands.	San Antonio Island: Bull Pt. light	17 06 50	24 59 15				
	Summit, 7,400 ft	17 04 00	25 17 00				
	St. Vincent Island: Porto Grande light	16 53 14	24 59 30	5 50	12 00	3.3	1.5
	St. Lucia Island: N. pt	16 49 00	24 47 08				
	Raza Island: E. pt	16 38 00	24 38 08				
	St. Nicholas Island: Lighthouse	16 34 00	24 16 00				
	Sal Island: N. pt. light	16 50 50	22 54 55				
	S. pt	16 34 00	22 55 42	7 30	1 20	4.4	2.0
	Boavista Island: NW. pt	16 13 20	22 55 44				
	NE. pt	16 11 00	22 42 00				
	Lighthouse	16 09 10	22 57 20				
	Mayo Island: English Road	15 07 30	23 12 42				
	St. Jago Island: Reta Pt. light	15 18 06	23 47 06				
	Porto Praya, S. light	14 53 40	23 31 45	5 50	12 00	4.8	2.2
	Fogo Island: N. S. da Luz, village	14 53 00	24 30 38				
	Brava Island: Lighthouse	14 50 30	24 40 00				
Bermuda Is.	Ireland Island: Dock yard clock tower	32 19 22	64 49 35	7 04	0 52	4.0	2.6
	Bastion C	32 19 37	64 49 15				
	Hamilton Island: Gibbs Hill light	32 15 05	64 49 40				
	St. Davids Island: Lighthouse	32 21 40	64 38 40				
	St. Paul Rocks: Summit, 64 ft	0 55 30	29 22 28				
		Lat. S.					
	Rocas Reef: NW. sandy islet	3 51 30	33 49 29	5 05	11 18	10.0	4.6
	Fernando Noronha: The Pyramid	3 50 30	32 25 29	5 00	11 13	6.0	2.7
	Ascension Island: Fort Thornton	7 55 20	14 24 35	5 20	11 30	2.0	0.9
	St. Helena Island: Obs. Ladder Hill	15 55 00	5 43 03	3 00	9 10	2.8	1.3
	Martin Vaz Rocks: Largest islet	20 27 42	28 46 57	3 35	9 48	3.5	1.6
	Trinidad Island: SE. pt	20 30 32	29 14 56	3 40	9 53	4.0	1.8
	Inaccessible Island: Center	37 19 00	12 23 00				
	Tristan da Cunha Islands: NW. pt	37 02 48	11 18 39	12 50	5 40	5.2	2.4
	Gough Island: Penguin Islet	40 19 11	9 56 11				

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

ISLANDS IN THE ATLANTIC OCEAN—Continued.

Coast.	Place.	Lat. S.	Long. W.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Falkland Islands.	Port Egmont: Observation spot	51 21 26	60 04 52	7 20	1 08	10.7	5.6
	Mare Harbor: Observation spot	51 04 11	58 30 56				
	Port Louis: Flagstaff, govt. house	51 32 20	58 08 04	5 31	11 27	4.3	2.2
	Port Stanley: Governor's house	51 41 10	57 51 30				
	Cape Pembroke: Lighthouse	51 40 40	57 41 48				
	South Georgia Island: N. cape	54 04 45	38 15 00				
	Shag Rocks: Center	53 48 00	43 25 00				
	Sandwich Islands: S. Thulé	59 34 00	27 45 00				
	Traverse I. volcano	55 57 00	26 33 00				
	New S. Orkney Is.: E. pt. Laurie I	60 54 00	44 25 00				
	E. summit Coronation I., 5,397 ft.	60 46 00	45 53 00				
	New S. Shetland Islands, Deception Island: Port Foster	62 55 36	60 35 00				
			Long. E.				
	Bouvets Island (Circumcision): Center	54 16 00	6 14 00				

ATLANTIC COAST OF EUROPE.

Coast.	Place.	Lat. N.	Long. W.	H. W.	L. W.	Spg.	Neap.
Great Britain.	Greenwich: Observatory	51 28 38	0 00 00	1 10	7 46	18.8	12.6
	Oxford: University Observatory	51 45 34	1 15 06				
			Long. E.				
	Cambridge: Observatory	52 12 52	0 05 41				
	North Foreland: Lighthouse	51 22 28	1 26 48	11 24	5 53	16.8	8.4
	South Foreland: Lighthouse	51 08 23	1 22 22	11 09	5 43	19.8	10.0
	Dungeness: Lighthouse	50 54 47	0 58 18	10 35	4 23	21.5	11.0
	Beachy Head: Lighthouse	50 44 15	0 13 00	11 10	4 58	19.8	10.1
			Long. W.				
	Southsea Castle: Lighthouse	50 46 35	1 05 15				
	Portsmouth: Observatory	50 48 03	1 05 58	11 31	4 19	13.2	6.7
	Southampton: Royal Pier light	50 53 45	1 24 00	0 35	6 48	12.8	6.5
	Hurst Castle: W. light	50 42 07	1 33 04	11 05	4 53	12.2	6.2
	Needles Rocks: Old lighthouse	50 39 42	1 35 25				
	St. Catharine: New lighthouse	50 34 30	1 17 47				
	Portland: Notch Bill light	50 31 10	2 27 30	6 29	0 09	6.7	1.0
	Start Point: Lighthouse	50 13 18	3 38 28	5 25	11 38	14.9	6.8
	Plymouth: Breakwater light	50 20 02	4 09 27	5 20	11 33	15.3	7.0
	Eddystone: Lighthouse	50 10 49	4 15 53				
	Falmouth: St. Anthony Pt. light	50 08 30	5 01 00				
	Lizard Point: W. lighthouse	49 57 40	5 12 06	4 45	10 58	14.2	6.5
	Porthcurnow: SE. cor. telegraph co.'s sta.	50 02 44	5 39 18				
	Lands End: Longships lighthouse	50 04 10	5 44 45				
	Scilly Islands: St. Agnes lighthouse	49 53 33	6 20 38	4 15	10 28	15.9	7.3
	Trevose Head: Lighthouse	50 33 00	5 01 55				
	Bideford: High lighthouse	51 04 00	4 12 30	5 45	11 58	22.7	11.4
	Lundy Island: Lighthouse, N. pt	51 12 05	4 40 35	5 00	11 13	26.9	13.5
	Bristol: Cathedral	51 27 24	2 35 55	7 00	0 48	31.3	15.7
	Cardiff: Lighthouse, W. pier	51 27 48	3 09 42	6 45	0 33	36.2	18.1
	Swansea: Lighthouse, W. pier	51 36 50	3 56 00	5 45	11 58	27.1	13.6
	Caldy Island: Lighthouse	51 37 52	4 40 59	5 40	11 53	25.3	12.7
	St. Anns: Upper lighthouse	51 41 00	5 10 30	5 41	11 54	24.0	12.0
	Smalls Rocks: Lighthouse	51 43 15	5 40 15	5 40	11 53	20.9	10.5
	Aberystwith: Lighthouse	52 24 20	4 05 40	7 25	1 13	14.2	7.1
	Bardsey Island: Lighthouse	52 45 00	4 47 50	7 24	1 12	14.9	7.5
	South Stack: Lighthouse on rocks	53 18 30	4 42 00				
	Holyhead: Lighthouse on old pier	53 18 54	4 37 01	10 00	3 48	15.8	7.9

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

ATLANTIC COAST OF EUROPE—Continued.

Coast.	Place.	Lat. N.	Long. W.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Great Britain.	Skerries Rocks: Lighthouse, highest I	53 25 15	4 36 20	......	......	......	......
	Bidstone: Lighthouse on hill	53 24 02	3 10 42	......	......	......	......
	Liverpool: Rock light	53 26 38	3 02 27	......	......	......	......
	Bidston Observatory	53 24 05	3 04 20	11 08	5 27	27.6	14.0
	Morecambe Bay: Fleetwood high light	53 55 03	3 00 20	11 00	4 48	27.4	13.9
	Calf of Man: Upper lighthouse	54 03 14	4 49 37	......	......	......	......
	Isle of Man: Ayre Pt. lighthouse	54 24 56	4 22 01	10 55	4 43	19.7	10.0
	St. Bees: Lighthouse	54 30 50	3 37 50	......	......	......	......
	White Haven: W. pierhead light	54 33 00	3 36 00	11 00	4 48	25.9	13.1
	Mull of Galloway: Lighthouse	54 38 10	4 51 20	11 05	4 53	14.8	8.9
	Ayr, Firth of Clyde: Lighthouse, N. side harbor	55 28 10	4 38 10	11 40	5 28	8.7	5.2
	Troon: Lighthouse, inner pier	55 32 55	4 41 00	......	......	......	......
	Ardrossan: S. breakwater light	55 38 27	4 49 28	11 35	5 23	8.8	5.3
	Pladda Island: Lighthouse	55 26 00	5 07 09	......	......	......	......
	Glasgow: Observatory	55 52 43	4 17 38	0 55	7 08	11.2	6.7
	Cantyre: Lighthouse	55 18 39	5 48 00	10 20	4 08	4.0	2.4
	Rhynns of Islay: Lighthouse	55 40 20	6 30 46	......	......	......	......
	Oban: Lighthouse on N. pier	56 24 50	5 28 20	5 10	11 22	12.8	7.7
	Skerryvore Rocks: Lighthouse	56 19 22	7 06 32	......	......	......	......
	Barra Head: Lighthouse	56 47 08	7 39 09	5 35	11 47	11.1	4.8
	Glas Island: Lighthouse, Scalpay I	57 51 25	6 38 28	......	......	......	......
	Stornoway: Arnish Pt. light	58 11 28	6 22 10	6 35	0 22	13.4	5.7
	Butt of Lewis: Lighthouse	58 30 40	6 16 01	......	......	......	......
	Cape Wrath: Lighthouse	58 37 30	4 59 41	......	......	......	......
	Dunnet Head: Lighthouse	58 40 16	3 22 25	......	......	......	......
	Kirkwall (Orkneys): New pierhead light	58 59 15	2 57 33	9 57	3 44	9.8	4.2
	Startpoint (Orkneys): Lighthouse	59 16 45	2 22 25	......	......	......	......
	North Ronaldsay: Lighthouse	59 23 24	2 22 45	......	......	......	......
	Fair Isle Skroo: Lighthouse	59 33 00	1 36 30	10 50	4 37	5.0	2.2
	Sumburgh Head: Lighthouse	59 51 15	1 16 20	9 35	3 22	5.2	2.2
	Blackness (Shetland Is.): Lighthouse pier	60 08 02	1 16 02	......	......	......	......
	Lerwick (Shetland Is.): Fort	60 09 22	1 08 41	10 20	4 17	6.0	2.6
	Hillswickness (Shetland Is.): S. extreme	60 27 20	1 29 50	......	......	......	......
	Balta I. (Shetland Is.): Cairn on E. side	60 44 25	0 47 30	9 30	3 17	6.4	2.7
	Pentland Skerries: Upper lighthouse	58 41 22	2 55 25	10 00	3 47	9.8	4.2
	Tarbertness: Lighthouse	57 51 54	3 46 30	......	......	......	......
	Buchanness: Lighthouse	57 28 15	1 46 22	0 24	6 36	11.2	6.1
	Aberdeen (Girdleness): Lighthouse	57 08 33	2 04 06	0 50	7 02	11.7	6.4
	Buddonness: Upper lighthouse	56 28 07	2 44 53	1 56	8 08	15.5	8.5
	Bell Rock: Lighthouse	56 26 03	2 23 06	......	......	......	......
	May Island: Lighthouse	56 11 00	2 33 22	......	......	......	......
	Inch Keith Rock: Lighthouse	56 02 09	3 08 05	......	......	......	......
	Edinburgh: City observatory	55 57 23	3 10 47	1 58	8 11	16.5	8.9
	Berwick: Lighthouse	55 46 00	1 59 00	2 08	8 28	15.0	7.5
	Farn Island: NW. lighthouse	55 37 00	1 39 00	......	......	......	......
	Coquet Island: Lighthouse	55 20 06	1 32 00	......	......	......	......
	Tynemouth: Souter Point lighthouse	54 58 10	1 21 30	......	......	......	......
	North Shields: Lighthouse	55 00 30	1 26 00	3 11	9 31	14.8	7.4
	Sunderland: N. pier light	54 55 07	1 21 30	3 12	9 32	14.5	7.3
	Hartlepool: Lighthouse	54 41 51	1 10 19	3 21	9 43	14.2	7.0
	Flamborough: New lighthouse	54 07 00	0 05 00	4 20	10 36	15.8	8.8
	Humber River: Killingholme middle light	53 39 00	0 12 00	......	......	......	......
			Long. E.				
	Spurn Head: Upper lighthouse	53 34 45	0 07 10	5 16	11 29	18.5	10.2
	Lowestoft: Lighthouse	52 29 14	1 45 24	9 47	3 35	6.2	3.6
	Orfordness: N. lighthouse	52 05 00	1 34 30	11 05	4 53	7.8	4.5
	Harwich: Landguard Pt. light	51 56 05	1 19 10	11 56	5 44	11.2	6.6

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

ATLANTIC COAST OF EUROPE—Continued.

Coast.	Place.	Lat. N.	Long. W.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Great Britain.	Cape Clear: Old lighthouse	51 26 02	9 29 03	3 50	10 03	8.8	4.4
	Fastnet Rock: Lighthouse	51 23 18	9 36 25				
	Mount Gabriel: Ordnance survey station	51 33 24	9 32 44				
	Castlehaven: Lighthouse	51 31 00	9 10 20	4 10	10 23	10.6	5.3
	Mizen Hill: Ordnance survey station	51 27 41	9 48 19				
	Bantry Bay: Roancarrig light	51 39 10	9 44 49				
	Bull Rock: Lighthouse	51 35 30	10 18 03				
	Skelligs Rocks: Lighthouse	51 46 14	10 32 45				
	Valentia: Lighthouse	51 56 00	10 19 16	3 30	9 43	10.8	4.6
	Port Magee	51 53 08	10 23 17				
	Dingle Bay: Light at entrance	52 07 15	10 15 30	3 40	9 53	10.7	4.6
	Blasket Islands: Westernmost rock	52 04 30	10 40 00				
	Smerwick: Signal tower	52 13 46	10 21 40	3 40	9 53	10.7	4.6
	Tralee Bay: Lighthouse	52 16 14	9 52 53	3 50	10 03	12.3	5.3
	Beeves Rocks: Lighthouse	52 39 00	9 01 18				
	Limerick: Cathedral	52 40 04	8 37 23	6 00	0 13	18.7	8.0
	Shannon River: Loop Head light	52 33 38	9 55 54				
	Eeragh Island: Lighthouse	53 08 55	9 51 30				
	Arran Island: Lighthouse	53 07 38	9 42 06	4 15	10 28	13.4	5.7
	Galway: Mutton I. light	53 15 13	9 03 10	4 19	10 19	15.1	6.4
	Golam Head: Tower	53 13 46	9 46 03				
	Slyne Head: N. lighthouse	53 23 58	10 14 01	4 16	10 29	13.2	5.7
	Clifden Bay: Gortrumnagh Hill	53 29 47	10 03 54				
	Tully Mountain: Ordnance survey station	53 35 00	10 00 15				
	Inishboffin: Lyon Head light	53 36 40	10 09 40	4 20	10 33	12.1	5.2
	Inishturk Island: Tower	53 42 27	10 06 41				
	Clew Bay: Inishgort light	53 49 34	9 40 12				
	Newport: Church	53 53 06	9 32 56				
	Clare Island: Lighthouse	53 49 30	9 59 00				
	Blacksod Point: Lighthouse	54 05 45	10 03 34				
	Eagle Island: W. lighthouse	54 17 00	10 05 31				
	Broadhaven: Guba Cashel light	54 16 00	9 53 00	4 50	11 03	10.4	4.5
	Dounpatrick Head: Ordnance survey station	54 19 36	9 20 41				
	Anghris Head: Ordnance survey station	54 16 33	8 46 02				
	Knocknarea: Tumulus	54 15 30	8 34 25				
	Sligo Bay: Black Rock light	54 18 00	8 37 00	5 10	11 23	11.4	5.3
	Knocklane: Ordnance survey station	54 20 50	8 40 14				
	Killybegs (Donegal Bay): St. Johns Pt. light	54 34 08	8 27 33	5 03	11 16	11.2	4.8
	Rathlin O'Birne Islet: Lighthouse	54 39 47	8 49 52				
	Aran Island: Rinrawros light	55 00 52	8 33 48				
	Bloody Foreland: Ordnance survey station	55 08 13	8 15 38				
	Tory Island: Lighthouse	55 16 26	8 15 00				
	Horn Head: Ordnance survey station	55 12 31	7 57 15				
	Melmore Head: Tower	55 15 14	7 47 12	5 28	11 41	11.6	5.3
	Fanad Point: Lighthouse	55 16 33	7 37 53				
	Glashedy Island: Ordnance survey station	55 19 07	7 23 51				
	Malin Head: Tower	55 22 50	7 22 22				
	Inishtrahull: Lighthouse	55 25 55	7 13 37				
	Inishowen Head: E. lighthouse	55 13 38	6 55 38				
	Moville: New Pier	55 10 20	7 02 20	6 55	0 43	7.5	3.4
	Londonderry: Cathedral	54 59 40	7 19 25	7 48	1 35	8.0	3.6
	Scalp Mountain: Ordnance survey station	55 05 23	7 21 51				
	Benbane Head: Summit	55 15 03	6 28 45				
	Rathlin Island: Altacarry lighthouse	55 18 05	6 10 45				
	Maiden Rocks: W. lighthouse	54 55 47	5 44 18	10 30	4 18	6.7	4.5
	Lough Larne: Farres Pt. lighthouse	54 51 07	5 47 21				
	Belfast Bay: Light, east side	54 40 20	5 49 30	10 42	4 06	9.3	6.3
	Mew Islands: Lighthouse	54 41 50	5 31 30				
	Donaghadee: Lighthouse	54 38 45	5 32 01	11 00	4 48	11.1	7.4
	South Rock: Light vessel	54 24 04	5 22 20				

MARITIME POSITIONS AND TIDAL DATA.

ATLANTIC COAST OF EUROPE—Continued.

Coast.	Place.	Lat. N.	Long. W.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Great Britain.	Dundrum Bay: St. John Pt. light	54 13 30	5 39 30				
	Carlingford Lough: Haulbowline Rk. lt.	54 01 10	6 04 45	10 45	4 33	15.8	9.2
	Drogheda: Lighthouse	53 43 00	6 15 00	10 45	4 33	11.6	6.8
	Rockabill: Lighthouse	53 35 47	6 00 20				
	Howth Peninsula: Bailey light	53 21 40	6 03 06	10 55	4 43	12.7	7.5
	Dublin: Observatory	53 23 13	6 20 17				
	N. wall light	53 20 47	6 13 33				
	Poolbeg: Lighthouse	53 20 30	6 09 00	11 00	4 48	13.0	7.6
	Kingstown: E. pier light	53 18 10	6 07 30	10 52	4 27	10.9	6.4
	Killiney Hill: Mapas obelisk	53 15 52	6 06 37				
	Bray Head: Ordnance survey station	53 10 39	6 04 55	10 30	4 18	11.8	6.9
	Wicklow: Upper light	52 57 54	6 00 08	10 10	3 58	8.7	5.1
	Tara Hill: Summit	52 41 55	6 13 01				
	Black Stairs Mountain: Ordnance survey station	52 32 55	6 48 17				
	Tory Hill: Ordnance survey station	52 20 53	7 07 31				
	Wexford: College	52 20 04	6 28 15	7 05	0 53	4.9	2.9
	Forth Mount: Ordnance survey station	52 18 57	6 33 41				
	Tuskar Rock: Lighthouse	52 12 09	6 12 35	5 30	11 43	8.8	5.1
	Great Saltee: S. end	52 06 41	6 37 15				
	Waterford: Hoop Pt. light	52 07 25	6 55 53	5 05	11 18	12.3	6.2
	Waterford: Cathedral	52 15 33	7 06 24				
	Great Newton Head: Metal Man Tower	52 08 13	7 10 15				
	Dungarvan: Ballinacourty light	52 04 27	7 33 05	5 00	11 13	12.4	6.2
	Knockmealdown Mount: Ordnance survey station	52 13 39	7 54 54				
	Helvick Head: Ordnance survey station	52 03 00	7 32 39				
	Mine Head: Lighthouse	51 59 33	7 35 08				
	Youghal: Lighthouse	51 56 34	7 50 34	5 02	11 15	12.6	6.3
	Capel Island: Tower	51 52 54	7 51 10				
	Ballycottin: Lighthouse	51 49 30	7 59 00	4 40	10 53	11.8	5.9
	Cork Harbor: Haulbowline Coal Wharf	51 50 33	8 18 20				
	Queenstown: Roches Pt. light	51 47 33	8 15 14	4 33	10 59	11.6	5.8
	Kinsale: Lighthouse, S. pt	51 36 11	8 31 58	4 30	10 43	11.4	5.7
	Seven Heads: Tower	51 34 14	8 42 51	4 20	10 33	10.7	5.3
	Galley Head: Light on summit	51 31 50	8 57 10				
	Stag Rocks: Largest	51 28 05	9 13 27				
	Alderney Harbor: Old pier light	49 43 00	2 12 00	6 21	0 16	17.2	7.6
	St. Heliers: Light on Victoria Pier	49 10 29	2 06 44	6 09	0 00	31.2	13.6
			Long. E.				
Norway.	Vardo: Fortress	70 22 00	31 07 30	5 40	11 57	9.0	5.1
	Vadso: Lighthouse	70 04 00	29 45 00				
	North Cape: Extreme	71 11 00	25 40 00				
	Fruholm: Lighthouse	71 06 00	23 59 00				
	Hammerfest: Lighthouse	70 40 15	23 40 00	2 20	8 40	8.3	4.7
	Tromso: Observatory	69 39 12	18 57 00	1 35	7 48	7.8	4.4
	Hekkingen: Lighthouse	69 36 05	17 50 15				
	Andenes: Lighthouse	69 19 30	16 08 00	0 42	6 55	7.0	4.0
	Lodingen (Hjertholm): Lighthouse	68 24 40	16 02 30				
	Lofoten Island: Skraaven I. light	68 09 20	14 40 40				
	Glopen light	67 53 15	13 04 30				
	Gryto: Lighthouse	67 23 15	13 52 30				
	Stot: Lighthouse	66 56 35	13 28 50				
	Trænen: Soe Islet light	66 25 50	11 59 50	11 35	5 23	6.9	3.3
	Bronnosund: Lighthouse	65 28 40	12 13 30				
	Villa: Lighthouse	64 32 55	10 42 10				
	Halten Island: Lighthouse	64 10 25	9 24 50				
	Koppem	63 48 25	9 44 45				
	Agdenes: Lighthouse	63 38 45	9 45 20				
	Trondheim: Mumkholmen flagstaff	63 27 04	10 23 30	11 18	5 04	8.4	4.1
	Grip: Church	63 13 11	7 36 05				
	Christiansund: Storvaden	63 07 01	7 43 35	11 00	4 48	5.0	2.9
	Freikallen	63 03 04	7 46 04				

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

ATLANTIC COAST OF EUROPE—Continued.

Coast.	Place.	Lat. N.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Norway.	Hestskjaer: Lighthouse	63 05 00	7 29 55	......	......	......	....
	Stemshesten	62 58 49	7 12 32	......	......	......	....
	Ærstenen: Lighthouse	62 48 20	6 36 10	......	......	......	....
	Svinoen Islet	62 19 38	5 16 25	......	......	......	....
	Hjœrringa Mountain: Summit	62 11 12	5 07 59	......	......	......	....
	Hornelen Mountain: Summit	61 51 21	5 15 11	......	......	......	....
	Batalden Island: Store	61 38 40	4 47 38	......	......	......	....
	Kinnsund: Lighthouse	61 33 35	4 46 45	......	......	......	....
	Alden	61 19 16	4 47 14	......	......	......	....
	Helliso: Lighthouse	60 45 05	4 42 55	......	......	......	....
	Bergen: Naval School Obsy	60 23 54	5 18 11	10 15	3 55	4.1	2.1
	Lorstakken Mountain: Summit	60 21 39	5 19 35	......	......	......	....
	Marstenen Islet: Lighthouse	60 07 50	5 01 00	......	......	......	....
	Furen Islet	59 57 44	5 03 30	......	......	......	....
	Ulsire: Lighthouse	59 18 20	4 52 35	......	......	......	....
	Hvidingso: Lighthouse	59 03 10	5 24 20	......	......	......	....
	Port Stavanger: Lighthouse	58 58 30	5 45 20	9 43	3 40	1.9	0.8
	Obristadbrœkke: Lighthouse	58 39 25	5 33 35	......	......	......	....
	Synesvarde Mountain: Summit	58 36 56	5 49 08	......	......	......	....
	Kompas Mountain: Summit	58 25 51	5 58 49	......	......	......	....
	Lister: Lighthouse	58 06 25	6 34 20	......	......	......	....
	Lindesnes: Lighthouse	57 58 55	7 03 10	......	......	......	....
	Ryvingen Island: Lighthouse	57 58 00	7 29 50	......	......	......	....
	Christianssand: Odderoen light	58 07 50	8 00 30	4 16	10 15	1.1	0.5
	Okso: Lighthouse	58 04 15	8 03 30	......	......	......	....
	Hamberg: Mill	58 15 02	8 31 36	......	......	......	....
	Arendal Inlet: Inner Torungerne light	58 24 40	8 47 55	4 17	10 10	1.0	0.7
	Jomfruland: Lighthouse	58 51 50	9 36 15	......	......	......	....
	Langotangen: Lighthouse	58 59 25	9 45 50	......	......	......	....
	Langesund: Church	59 00 01	9 45 14	......	......	......	....
	Frederiksværn: Lookout tower	58 59 34	10 03 28	4 34	10 00	1.3	1.0
	Svenor: Lighthouse	58 58 05	10 09 26	......	......	......	....
	Fœrder Islet: Lighthouse	59 01 35	10 31 55	......	......	......	....
	Fulehuk: Lighthouse	59 10 30	10 36 25	......	......	......	....
	Basto: Lighthouse	59 23 10	10 32 45	......	......	......	....
	Horten: Church	59 25 34	10 29 52	......	......	......	....
	Holmestrand: Church	59 29 23	10 19 15	......	......	......	....
	Drobak: Church	59 39 52	10 38 08	......	......	......	....
	Oscarsberg: Fort flagstaff	59 40 21	10 36 55	......	......	......	....
	Christiania: Observatory	59 54 44	10 43 23	5 22	10 37	1.2	0.9
	Stromtangen (Torgauten): Lighthouse	59 09 00	10 50 15	......	......	......	....
	Fredriksten: Fort clock tower	59 07 08	11 24 09	......	......	......	....
	Torbjornskjær: Lighthouse	58 59 45	10 47 20	......	......	......	....
	Koster: Lighthouse	58 54 05	11 00 45	......	......	......	....
Sweden.	Stromstad: Steeple	58 56 24	11 10 28	......	......	......	....
	Nord Koster Islands: Lighthouse	58 54 12	11 00 36	......	......	......	....
	Wadero Island: Lighthouse	58 32 45	11 02 16	......	......	......	....
	Hollo Island: Lighthouse	58 20 12	11 13 24	......	......	......	....
	Paternoster Rocks: Lighthouse	57 53 49	11 28 04	......	......	......	....
	Gottenburg: Signal station	57 40 58	11 53 54	......	......	......	....
	Nidingen Islet: Lighthouse	57 18 15	11 54 16	......	......	......	....
	Warberg: Castle tower	57 06 26	12 14 32	......	......	......	....
	Falkenberg: Church	56 54 08	12 29 48	......	......	......	....
	Halmstad: Palace	56 40 21	12 51 38	......	......	......	....
	Engelholm: Church	56 14 40	12 51 47	......	......	......	....
	Kullen Point: Lighthouse	56 18 06	12 27 11	......	......	......	....
	Helsingborg: Lighthouse	56 02 37	12 41 30	......	......	......	....
	Landskrona: Lighthouse	55 52 00	12 49 48	......	......	......	....
	Lund: Royal Observatory	55 41 52	13 11 15	......	......	......	....
	Malmo: Lighthouse	55 36 47	12 59 49	......	......	......	....
	Falsterbo: Lighthouse	55 23 00	12 49 02	......	......	......	....

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

ATLANTIC COAST OF EUROPE—Continued.

Coast.	Place.	Lat. N.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	*h. m.*	*h. m.*	*ft.*	*ft.*
Sweden.	Trelleborg: Lighthouse	55 22 00	13 09 20				
	Ystad: Lighthouse	55 25 42	13 49 38				
	Sandhammaren: Lighthouse	55 22 58	14 11 10				
	Hano Island: Lighthouse	56 00 54	14 50 57				
	Karlshamn: Lighthouse	56 10 04	14 52 02				
	Karlskrona: Stumholm Tower	56 09 45	15 36 05				
	Oland Island: Light on S. pt	56 11 50	16 24 04				
	Gottland Island: Hoburg light, S. pt	56 55 18	18 11 06				
	Ostergarns light	57 26 29	18 59 27				
	Faro Island: Holmadden light	57 57 24	19 22 36				
	Sparo Vestervik: Granso light	57 45 38	16 40 36				
	Haradsskar Islet: Lighthouse	58 08 52	16 59 22				
	Norrkopings Inlopp: Lighthouse	58 17 55	16 11 28				
	Landsort: Lighthouse	58 44 26	17 52 09				
	Stockholm: Observatory	59 20 33	18 03 30				
	Upsala: Observatory	59 51 29	17 37 32				
	Norrtelge: Inn	59 45 24	18 41 34				
	Soderarm: Lighthouse	59 45 15	19 24 34				
	Svartklubben: Lighthouse	60 10 35	18 49 49				
	Osthammar: Church	60 15 19	18 22 36				
	Oregrund: Clock tower	60 20 26	18 26 33				
	Djursten: Lighthouse	60 22 15	18 24 21				
	Forsmark: Church	60 22 26	18 09 49				
	Orskar Rock: Lighthouse	60 31 41	18 22 38				
	Gefle: Church	60 40 29	17 08 29				
	Eggegrund Islet: Lighthouse	60 43 48	17 33 50				
	Hamrange: Church	60 55 57	17 02 57				
	Soderhamm: Courthouse	61 18 22	17 04 18				
	Enanger: Church	61 32 54	17 01 51				
	Hudiksvalls: Courthouse	61 43 57	17 07 37				
	Gnarp: Church	62 02 51	17 16 22				
	Sundsvall: Church	62 23 30	17 19 05				
	Lungo: Lighthouse	62 38 35	18 05 05				
	Skags Head: Lighthouse	63 11 55	19 02 50				
	Holmogadd: Lighthouse	63 35 34	20 45 35				
	Umea: Bredekar Light	63 39 33	20 18 35				
	Bjuroklubb: Lighthouse	64 28 50	21 34 45				
	Pitea	65 19 10	21 30 00				
	Rodkallen: Lighthouse	65 18 53	22 21 55				
	Maloren: Lighthouse	65 31 30	23 34 00				
Russia.	Tornea: Lighthouse	65 48 30	24 12 00				
	Uleaborg: Karlo I. light	65 02 20	24 34 00				
	Ulko Kalla Rock: Lighthouse	64 20 05	23 27 00				
	Norrsher Islet: Kvarken light	63 14 08	20 37 40				
	Kaske: Shelgrund I. light	62 20 06	21 11 24				
	Bierneborg: Sebsher light	61 28 29	21 22 34				
	Nuistad: Ensher light	60 43 10	21 01 00				
	Abo: Observatory	60 26 57	22 17 03				
	Aland Island: Shelsher light	60 24 45	19 34 00				
	Ekkere light	60 13 20	19 31 20				
	Logsher light	59 50 50	19 54 05				
	Bogsher: Beacon	59 31 11	20 25 50				
	Ute Islet: Lighthouse	59 46 30	21 22 00				
	Gange: Gange I. light	59 46 00	22 58 08				
	Rensher: Lighthouse	59 56 10	24 24 43				
	Helsingfors: Observatory	60 09 43	24 57 17				
	Soder Skars: Lighthouse	60 06 40	25 25 51				
	Kalboden Island: Light vessel	59 58 45	25 37 30				
	Rodsher Island: Lighthouse	59 58 08	26 41 05				
	Hogland Island: Lower light	60 00 40	27 01 40				
	Upper light	60 06 22	26 58 44				

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

ATLANTIC COAST OF EUROPE—Continued.

Coast.	Place.	Lat. N.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Russia.	Sommer Island: Lighthouse	60 12 31	27 33 46				
	Vieborg Bay: Nelva I. light	60 14 43	27 58 36				
	Stirsudden: Lighthouse	60 11 05	29 03 01				
	Kronstadt: Light on Frederikstadt bastion	59 58 14	29 47 12				
	Cathedral	59 59 44	29 46 07				
	St. Petersburg: Observatory	59 56 30	30 19 22				
	Pulkowa: Observatory	59 46 19	30 19 40				
	Peterhof: Pier-head light	59 53 26	29 54 54				
	Oranienbaum: Lighthouse	59 55 40	29 46 38				
	Seskar Islet: Lighthouse	60 02 08	28 23 01				
	Narva: Light S. pt. of entrance	59 28 04	28 03 31				
	Stensher Rock: Lighthouse	59 49 10	26 23 00				
	Ekholm Islet: Lighthouse	59 41 06	25 48 58				
	Koksher: Lighthouse	59 42 00	25 02 37				
	Revel: Light N. end of W. mole	59 27 05	24 46 10				
	Cathedral	59 26 28	24 44 45				
	Nargen Island: Lighthouse	59 36 22	24 31 57				
	Surop: W. light	59 27 55	24 24 05				
	Baltic Port: Lighthouse	59 21 30	24 04 30				
	Odenskholm Island: Lighthouse	59 18 06	23 23 15				
	Takhkona Point: Lighthouse	59 05 25	22 36 15				
	Dago Island: Dagerort light	58 55 02	22 11 36				
	Filzand Island: Lighthouse	58 23 02	21 49 56				
	Svalferort Tzerel: Lighthouse	57 54 37	22 04 15				
	Kuino: Lighthouse	58 05 50	23 59 34				
	Pernau: Light at S. entrance	58 23 10	24 49 25				
	Riga: Ust Dyinski light	57 03 38	24 01 27				
	Cathedral of St. Peter	56 57 01	24 06 38				
	Runo Island: Lighthouse	57 48 02	23 15 00				
	Domesnes: Lighthouse	57 48 10	22 39 15				
	Windau: Light on S. jetty	57 24 00	21 34 00				
	Libau: Light at entrance of port	56 31 01	20 59 40				
Germany.	Memel: Lighthouse	55 43 45	21 06 06				
	Heiligen Creutz: Church tower	54 53 47	20 01 25				
	Brusterort: Lighthouse	54 57 40	19 59 06				
	Pillau: Lighthouse	54 38 25	19 53 55				
	Fischausen: City Hall tower	54 43 49	20 00 39				
	Konigsberg: Observatory	54 42 50	20 29 46				
	Tolkemit: Church tower	54 19 19	19 31 58				
	Elbing: Church tower	54 09 44	19 23 58				
	Tiegenort: Church tower	54 16 30	19 08 37				
	Dantzig: Observatory	54 21 18	18 39 54				
	Neufahrwasser light	54 24 28	18 39 59				
	Weichselmunde: Fortress tower	54 23 51	18 41 03				
	Putziger Heisternest: Church tower	54 12 16	18 40 35				
	Oxhoft: Lighthouse	54 33 09	18 33 46				
	Hela: Lighthouse	54 36 06	18 49 04				
	Rixhoft: Lighthouse	54 49 55	18 20 29				
	Leba: Church tower	54 45 29	17 33 38				
	Stopelmunde: Church	54 35 16	16 51 35				
	Jershoft: Lighthouse	54 32 29	16 32 50				
	Rugenwalde: St. Mary's Church	54 25 27	16 24 52				
	Coslin: St. Mary's Church	54 11 28	16 11 05				
	Funkenhagen: Lighthouse	54 14 40	15 52 39				
	Colberg: St. Mary's Church	51 10 40	15 34 44				
	Gross-Horst: Lighthouse	54 05 47	15 04 06				
	Cammin: Cathedral tower	53 58 29	14 46 36				
	Wollin: Church tower	53 50 41	14 37 12				
	Stettin: N. Castle tower	53 25 41	14 33 52				
	Swinemunde: Lighthouse	53 55 03	14 17 19				

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

ATLANTIC COAST OF EUROPE—Continued.

Coast.	Place.	Lat. N.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Germany.	Streckelsberg: Survey station near beacon	54 03 08	14 01 17				
	Usedom: Church tower	53 52 17	13 55 26				
	Lassau: Church tower	53 56 59	13 51 13				
	Wolgast: Church tower	54 03 18	13 46 51				
	Griefswald: St. Nicholas Church	54 05 49	13 22 53				
	Griefswalder Oie: Lighthouse	54 15 02	13 55 42				
	Granitz: Castle tower	54 22 56	13 37 54				
	Bergen: Church tower	54 25 08	13 26 11				
	Arkona: Lighthouse	54 40 53	13 26 12				
	Stralsund: St. Mary's Church	54 18 42	13 05 30				
	Darsserort: Lighthouse	54 28 28	12 30 23				
	Wustrow: Church	54 20 47	12 24 02				
	Ribnitz: Church tower	54 14 42	12 26 04				
	Warnemunde: Church	54 10 42	12 05 19				
	Rostock: St. Jacob's Church	54 05 27	12 08 10				
	Diedrichshagen: Survey station	54 06 32	11 46 04				
	Basdorf: Survey station	54 08 00	11 41 54				
	Wismar: St. Nicholas Church	53 53 50	11 28 09				
	Hohenschonberg: Survey station	53 58 54	11 05 54				
	Travemunde: Lighthouse	53 57 44	10 52 59				
	Burg: Church tower	54 26 16	11 11 59				
	Marienleuchte: Lighthouse	54 29 43	11 14 29				
	Petersdorf: Church tower	54 28 54	11 04 18				
	Hessenstein: Flagstaff of lookout tower	54 19 47	10 32 59				
	Schonberg: Church	54 23 52	10 22 24				
	Bulk: Lighthouse	54 27 25	10 12 04				
	Kiel: Observatory	54 20 28	10 08 53				
	Eckemforde: Church	54 28 25	9 50 23				
	Schleswig: Cathedral	54 30 55	9 34 23				
	Kappeln: Church	54 39 48	9 56 13				
	Flensberg: Church	54 47 05	9 26 20				
	Duppel: Survey station	54 54 28	9 45 35				
	Schleimunde: Lighthouse	54 40 23	10 02 23				
	Augustenburg: Church	54 56 48	9 52 20				
	Hugeberg: Survey station	54 58 05	9 58 41				
	Apenrade: Church	55 02 46	9 25 18				
	Skoorgaarde: Survey station	55 03 52	9 23 35				
	Ballum: Church	55 05 31	8 39 41				
	List: E. lighthouse	55 03 04	8 26 50	0 20	6 33	5.2	3.0
	Keitum: Church	54 54 13	8 22 03				
	Fohr: St. Nicholas Church	54 41 51	8 33 13	1 35	7 47	7.8	4.5
	Galgenberg: Survey station	54 41 21	8 33 58				
	Husum: Church	54 28 43	9 03 21	2 10	8 23	10.8	6.2
	Tonning: Church	54 19 08	8 56 38	1 45	7 57	11.0	6.4
	Busum: Church	54 07 52	8 51 53	1 11	7 24	11.7	6.8
	Helgoland: Lighthouse	54 10 57	7 53 11	11 29	5 17	8.1	4.7
	Scharhorn: Beacon	53 57 15	8 24 35				
	Neuwerk: Lighthouse	53 55 01	8 29 58				
	Cuxhaven: Lighthouse	53 52 25	8 42 43	0 39	6 51	10.1	5.8
	Stade: Church steeple	53 36 12	9 28 48				
	Steinkirchen: Church	53 33 43	9 36 40	4 00	10 13	8.5	4.9
	Altona: Observatory	53 32 45	9 56 35				
	Hamburg: Old Observatory	53 33 07	9 58 27	5 00	11 12	6.1	3.5
	Imperial Marine Observatory	53 32 52	9 58 21				
	Berlin: Urania Observatory	52 31 31	13 21 52				
	Treptow Observatory	52 29 07	13 28 33				
	Harburg: Lighthouse	53 28 30	9 59 37				
	Hohe Weg: Lighthouse	53 42 50	8 14 48	0 25	6 38	10.1	5.7
	Langwarden: Church	53 36 20	8 18 30				
	Bremerhaven: New harbor light	53 32 52	8 34 25	0 54	7 07	10.4	5.8
	Minsener Sand: Light vessel	53 46 57	8 04 47	0 10	6 23	9.5	5.3
	Schillighorn: Lighthouse	53 42 21	8 01 43				

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

ATLANTIC COAST OF EUROPE—Continued.

Coast.	Place.	Lat. N.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Germany.	Wilhelmshaven: Observatory	53 31 52	8 08 47	0 04	6 17	13.2	7.4
	Wangeroog: Lighthouse	53 47 25	7 54 09	11 27	5 15	8.0	4.5
	Spikeroog: Church	53 46 19	7 41 45	......	......	......	....
	Langeoog: Belvedere	53 45 06	7 35 41	......	......	......	....
	Balstrum: Church	53 43 46	7 22 03	......	......	......	....
	Norderney: Lighthouse	53 42 39	7 13 58	11 05	4 53	7.3	4.1
	Juist: Church	53 40 45	6 59 53	......	......	......	....
	Emden: City Hall tower	53 22 06	7 12 25	0 24	6 36	8.9	5.0
Denmark.	Falster: Gjedser light	54 33 50	11 58 03	......	......	......	....
	Moen Island: Stege Church spire	54 59 03	12 17 16	......	......	......	....
	Moen light, SE. pt	54 56 46	12 32 40	......	......	......	....
	Prœste: Church spire	55 07 24	12 03 07	......	......	......	....
	Kjorge: Church tower	55 29 44	12 07 36	......	......	......	....
	Amager Island: Hollœnderby Ch. spire	55 35 45	12 38 24	......	......	......	....
	Nordse Rase light	55 38 10	12 41 26	......	......	......	....
	Copenhagen: University Observatory	55 41 13	12 34 41	9 33	3 21	0.6	0.3
	Bornholm: Ronne light	55 05 40	14 42 00	......	......	......	....
	Christianso Island: Great tower	55 19 19	15 11 39	......	......	......	....
	Kronberg: High spire	56 02 20	12 32 02	......	......	......	....
	Nakkehooed: Upper light	56 07 10	12 20 50	......	......	......	....
	Hesselo Island: Lighthouse	56 11 50	11 42 50	......	......	......	....
	Anholt Island: Lighthouse	56 44 16	11 39 15	......	......	......	....
	Spodsbjerg: Lighthouse	55 58 36	11 51 36	......	......	......	....
	Roeskilde: Cathedral	55 38 34	12 05 02	......	......	......	....
	Nykjobing: Church tower	55 55 30	11 40 29	......	......	......	....
	Oddensby: Church tower	55 57 52	11 24 06	......	......	......	....
	Sejro Island: Sejro Point light	55 55 09	11 05 07	......	......	......	....
	Kallundborg: Church	55 40 50	11 05 04	......	......	......	....
	Omo Island: Church	55 09 48	11 09 32	......	......	......	....
	Vordingborg: Waldemar's tower	55 00 26	11 54 59	......	......	......	....
	Veiro Island: Lighthouse	55 02 19	11 22 23	......	......	......	....
	Langeland Island: Fakkebjerg light	54 44 23	10 42 13	......	......	......	....
	Æro Island: Church spire	54 51 14	10 24 11	......	......	......	....
	Lyo Island: Church tower	55 02 34	10 09 16	......	......	......	....
	Assens: Church tower	55 16 09	9 53 50	......	......	......	....
	Baago Island: Lighthouse	55 17 44	9 48 09	......	......	......	....
	Kolding: Castle tower	55 29 31	9 28 40	......	......	......	....
	Bogense: Church spire	55 34 03	10 05 29	......	......	......	....
	Nyborg: Church spire	55 18 41	10 47 47	......	......	......	....
	Turo Island: Church spire	55 03 00	10 40 02	......	......	......	....
	Svendborg: Frue Church	55 03 37.	10 36 48	......	......	......	....
	Endelave Island: Church tower	55 45 32	10 16 20	......	......	......	....
	Samso Island: Koldby Church tower	55 48 02	10 33 37	......	......	......	....
	Horsens: Frelser Church spire	55 51 44	9 51 19	......	......	......	....
	Tuno Island: Lighthouse	55 56 58	10 26 51	......	......	......	....
	Samsoe Island: Nordby Church tower	55 57 06	10 33 00	......	......	......	....
	Aarhus: Cathedral spire	56 09 26	10 12 50	......	......	......	....
	Hjelm Islet: Lighthouse	56 08 00	10 48 32	......	......	......	....
	Fornæs: Lighthouse	56 26 36	10 57 40	......	......	......	....
	Hals: Church tower	56 59 54	10 18 53	......	......	......	....
	Aalborg: St. Rudolph's Church	57 02 54	9 55 22	......	......	......	....
	Cape Skaw, or Skagen: Old lighthouse	57 43 46	10 36 38	5 46	11 58	1.0	.05
	Hirtshals: Lighthouse	57 35 06	9 56 44	4 18	10 30	1.2	.07
	Haustholm: Lighthouse	57 06 50	8 36 10	......	......	......	....
	Boobjerg: Lighthouse	56 30 48	8 07 23	......	......	......	....
	Ringkjobing: Church spire	56 05 27	8 14 52	......	......	......	....
	Loune: Church tower	55 47 17	8 14 36	2 35	8 47	2.1	1.2
	Blaabjerg: Summit, 100 ft	55 44 50	8 14 43	......	......	......	....
	Guldager: Church	55 31 52	8 24 12	2 35	8 47	4.5	2.6
	Fano Island: Nordby Church	55 26 26	8 24 03	2 34	8 46	4.7	2.7
	Mano Island: Church spire	55 16 11	8 32 38	......	......	......	....

MARITIME POSITIONS AND TIDAL DATA.

ATLANTIC COAST OF EUROPE—Continued.

Coast.	Place.	Lat. N.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Holland.	Niewe Diep: Time-ball station	52 57 50	4 46 36	7 17	1 05	3.9	2.0
	Amsterdam: W. church tower	52 22 30	4 53 01				
	Utrecht: Observatory	52 05 10	5 07 45				
	Leyden: Observatory	52 09 20	4 29 03				
	The Hague: Church tower	52 04 40	4 18 30				
	Scheveningen: Lighthouse	52 06 16	4 15 10				
	Brielle: Lighthouse	51 54 29	4 10 45	2 50	9 02	4.8	2.5
	Rotterdam: Time-ball station	51 54 30	4 28 50	3 35	9 47	6.7	3.5
	Hellevoetsluis: Time-ball station	51 49 19	4 07 40	2 20	8 32	5.2	2.8
	Willemstadt: Lighthouse	51 41 48	4 26 26	3 20	9 32	9.8	5.2
	Goedereede: Light on church tower	51 49 08	3 58 35				
	Flushing: Time-ball station	51 26 33	3 35 48				
	Light, Westhaven bastion	51 26 24	3 34 32	0 44	6 56	14.7	7.8
Belgium.	Brussels: New observatory	50 47 56	4 21 44				
	Antwerp: Observatory	51 12 28	4 24 44	4 15	10 27	14.8	7.8
	Notre Dame Cathedral	51 13 17	4 24 12				
	Blankenberghe: Fort lighthouse	51 18 47	3 06 54	0 05	6 17	12.5	6.7
	Ostend: Lighthouse	51 14 13	2 55 51	0 02	6 32	16.1	8.4
	Church tower	51 13 50	2 55 22				
	Nieuport: Templars tower	51 07 53	2 45 34	0 10	6 22	15.7	8.4
France.	Paris: Observatory	48 50 11	2 20 15				
	Dunkerque: Tower	51 02 09	2 22 31	11 58	5 58	16.8	8.5
	Gravelines: Light on N. breakwater	51 00 18	2 06 34	11 59	6 16	19.0	9.6
	Calais: Light on old fort	50 57 45	1 51 07	11 39	6 13	21.0	10.7
	Cape Gris Nez: Lighthouse	50 52 10	1 35 02	11 17	5 51	21.5	11.0
	Boulogne, C. Alprech: Lighthouse	50 41 57	1 33 47	11 18	5 52	25.2	12.8
	Abbeville: Tower	50 07 05	1 49 56				
	Cayeux: Lighthouse	50 11 42	1 30 46				
	Dieppe: W. jetty light	49 56 06	1 05 01	10 54	5 48	27.3	13.3
	Ailly Point: Lighthouse	49 55 04	0 57 35				
	St. Valery en Caux: Light on W. breakwater	49 52 28	0 42 34	10 29	5 33	26.8	13.1
	Fécamp: N. jetty light	49 46 05	0 22 12	10 06	5 02	23.3	11.4
	Cape La Heve: S. light	49 30 04	0 04 08				
	Havre: S. jetty light	49 29 01	0 06 22	9 03	4 14	22.5	11.0
	Honfleur: Hospital jetty light	49 25 32	0 13 43				
			Long. W.				
	Caen: Church tower	49 11 14	0 21 10				
	Port Corseulles: W. jetty light	49 20 18	0 27 24				
	Point De Ver: Lighthouse	49 20 28	0 31 08				
	Cape La Hougue: Lighthouse	49 34 19	1 16 21	8 13	2 45	18.5	8.2
	Cape Barfleur: Lighthouse	49 41 50	1 15 56	8 14	2 37	17.0	7.5
	Cherbourg: Light, W. head of breakwater	49 40 29	1 43 44				
	Naval Observatory	49 38 54	1 38 08	7 30	1 44	17.6	7.8
	Cape La Hague: Lighthouse	49 43 22	1 57 15				
	Casquets Rocks: Light on NW. rock	49 43 17	2 22 41	6 20	0 15	15.5	6.9
	Port St. Peter, Guernsey: Light on Castle Coonet Breakwater	49 27 13	2 31 31	6 12	0 07	26.0	11.5
	Douvres Rocks: Lighthouse	49 06 28	2 48 49				
	Cape Carteret: Lighthouse	49 22 27	1 48 25	6 07	0 15	30.8	13.5
	Coutances: Cathedral tower	49 02 54	1 26 39				
	Granville: Lighthouse	48 50 07	1 36 46	5 50	0 09	36.7	16.0
	Chausey Is.: Light on SE. end of large id.	48 52 13	1 49 20	5 55	0 04	34.7	15.2
	St. Malo: Rochebourne light	48 40 18	1 58 41	5 43	0 04	36.0	15.7
	Cape Frehel: Lighthouse	48 41 05	2 19 08				
	Heau de Brehat: Lighthouse	48 54 33	3 05 11	5 35	12 00	30.4	13.3
	Morlaix, Ile Noire: Lighthouse	48 40 23	3 52 33	5 00	11 25	23.1	10.6
	De Bas Islet: Lighthouse	48 44 45	4 01 38	4 35	11 00	22.0	10.1
	Abervrach: Light on Vrach Islet	48 36 57	4 34 34	4 00	10 25	20.6	9.5
	Ushant: Stiff Point light	48 28 31	5 03 26	3 35	10 00	18.9	8.7

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

ATLANTIC COAST OF EUROPE—Continued.

Coast.	Place.	Lat. N.	Long. W.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		′ ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
France.	Brest: Observatory	48 23 32	4 29 36	3 23	9 45	19.5	9.0
	Brest (approach): Quelern light	48 19 10	4 34 28	......	......	......	....
	De Sein Islet: Lighthouse	48 02 40	4 52 03	3 25	9 53	17.2	7.9
	Bec du Raz: Lighthouse	48 02 28	4 45 25	......	......	......	....
	Audierne: Pierhead light	48 00 47	4 32 50	3 04	9 31	11.1	5.1
	Penmarch Rocks: Lighthouse	47 47 52	4 22 30	3 05	9 34	13.3	6.1
	Glenan Islands: Light, Penfret I	47 43 17	3 57 15	3 00	9 27	13.0	6.0
	De Groix Island: Lighthouse	47 38 51	3 30 35	......	......	......	....
	Lorient: Church-tower light	47 44 53	3 21 31	3 09	9 36	13.8	6.3
	Belle Isle: Lighthouse	47 18 42	3 13 38	3 25	9 50	16.6	7.7
	Port Haliguen: Light on N. jetty	47 29 10	3 06 09	3 35	9 58	16.9	7.9
	Haedic Island: Lighthouse	47 19 18	2 50 07	3 20	9 46	16.7	7.7
	Port Navalo: Lighthouse	47 32 53	2 55 08	3 45	10 08	16.6	7.7
	Vannes: St. Pierre Church	47 39 30	2 45 28	5 47	12 11	15.8	7.4
	Le Four Rock: Lighthouse	47 17 53	2 38 05	......	......	......	....
	Croisic: End of breakwater	47 18 30	2 31 25	3 25	9 47	16.7	7.7
	Guerande: Steeple	47 19 44	2 25 48	......	......	......	....
	Port St. Nazaire: Lighthouse	47 16 18	2 11 50	3 35	9 56	16.6	7.7
	Paimbœuf: Steeple	47 17 17	2 02 09	4 18	10 39	17.0	7.9
	Nantes: Cathedral	47 13 08	1 32 59	5 50	12 28	16.5	7.7
	Noir Moutier Island: Lighthouse	47 00 41	2 13 16	3 05	9 26	16.7	7.7
	Le Pilier Island: Lighthouse	47 02 35	2 21 37	......	......	......	....
	D'Yeu Island: Lighthouse	46 43 04	2 22 56	3 18	9 40	14.7	6.8
	La Chaume: Lighthouse	46 29 38	1 47 45	3 20	9 44	12.7	5.9
	Point de Grouin du Cou: Lighthouse	46 20 41	1 27 49	......	......	......	....
	Ré Island: Light, NW. pt	46 14 40	1 33 40	......	......	......	....
	Rochelle: E. Quay light	46 09 25	1 08 57	3 27	9 22	16.6	7.7
	Aix Island: Lighthouse	46 00 36	1 10 40	3 27	9 22	16.6	7.7
	Rochefort: Hospital	45 56 37	0 57 50	3 45	9 55	16.7	7.7
	Oleron Island: Light, NW. pt	46 02 49	1 24 37	......	......	......	....
	Point de la Coubre: Lighthouse	45 41 39	1 15 16	......	......	......	....
	Point Cordouan: Lighthouse	45 35 14	1 10 24	3 35	9 53	16.8	7.8
	Point de Grave: Lighthouse	45 34 10	1 04 27	......	......	......	....
	Bordeaux: University Obsy., Floirac	44 50 07	0 31 23	6 30	0 12	15.3	7.1
	Bayonne: Cathedral	43 29 29	1 28 43	......	......	......	....
	Biarritz: Lighthouse	43 29 38	1 33 16	......	......	......	....
	St. Jean de Luz: St. Barbe Point light	43 23 58	1 39 53	3 07	9 14	12.3	5.8
	Hendaye: Abbadia Observatory	43 22 52	1 45 02	......	......	......	....
Spain and Portugal.	Fuenterrabia: Light on Cape Higuera	43 23 30	1 47 30	......	......	......	....
	Port Pasages: Light at entrance	43 20 05	1 56 05	......	......	......	....
	San Sebastian: Monte Igueldo light	43 19 22	2 01 40	2 55	9 05	11.7	5.5
	Bilbao: Light on Galea Castle	43 22 36	3 04 06	2 50	9 03	12.7	5.9
	Castro Urdiales: Santa Ana Castle light	43 24 20	3 16 10	2 50	9 03	11.8	5.5
	Santoña: Pescador Point light	43 28 36	3 28 06	2 55	9 07	12.3	5.7
	Santander: Cape Mayor light	43 29 30	3 47 40	3 05	9 18	14.8	6.9
	San Martin de la Arena: Lighthouse	43 26 50	4 01 00	3 00	9 14	11.7	5.5
	San Vincent de la Barquera: End of new mole	43 23 35	4 24 55	3 00	9 14	10.4	4.9
	Rivadesella: Mount Somos light	43 31 00	5 07 10	......	......	......	....
	Gijon: Santa Catalina light	43 32 48	5 40 11	2 50	9 03	13.5	6.3
	Aviles: Lighthouse	43 38 05	5 56 00	2 45	8 58	12.0	4.9
	Rivadeo: Lighthouse	43 34 40	7 03 00	2 45	8 58	14.4	3.9
	Estaca Point: Lighthouse	43 47 20	7 42 00	......	......	......	....
	Port Cedeira: Lighthouse	43 39 00	8 05 30	2 43	8 56	14.8	6.1
	Ferrol: Old naval observatory	43 29 30	8 13 29	2 44	8 57	14.9	6.1
	Priorino Chico light	43 27 30	8 20 20	......	......	......	....
	Coruña: Hercules Tower light	43 23 10	8 24 26	2 43	8 56	14.8	6.1
	Cape Finisterre: Lighthouse	42 52 45	9 15 28	2 42	8 55	10.0	4.6
	Vigo: Cres I. light	42 12 30	8 54 00	......	......	......	....
	Oporto: Light, N. S. de Luz	41 09 10	8 40 35	2 25	8 38	10.0	4.3

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

ATLANTIC COAST OF EUROPE—Continued.

Coast.	Place.	Lat. N.	Long. W.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Spain and Portugal.	Coimbra: Royal Observatory	40 12 25	8 25 47	....	....	....	....
	Cape Mondego: Lighthouse	40 10 47	8 54 15	2 20	8 35	7.0	3.0
	Berlanga Island: Lighthouse	39 24 49	9 30 29	....	....	....	....
	Peniche: Lighthouse	39 21 00	9 22 30	2 05	8 15	7.8	3.4
	Cape Roca: Lighthouse	38 46 49	9 29 46	....	....	....	....
	Lisbon: Royal Observatory, Tapada	38 42 31	9 11 10	2 20	8 05	11.1	4.8
	Setubal: Lighthouse	38 29 15	8 56 00	2 10	8 20	11.6	5.0
	Cape St. Vincent: Lighthouse	37 01 20	8 58 00	....	....	....	....
	Lagos: Church	37 07 48	8 39 53	1 55	8 08	13.0	5.6
	Cape Sta. Maria: Lighthouse	36 58 23	7 51 48	....	....	....	....
	Ayamonte: Lighthouse	37 11 00	7 24 00	....	....	....	....
	Huelva: Plaza at head of mole	37 15 08	6 57 12	....	....	....	....
	San Lucar: Chipiona light	36 43 58	6 26 30	1 15	7 28	12.3	5.6
	Cadiz: Observatory of San Fernando	36 27 42	6 12 18	....	....	....	....
	San Sebastian light	36 31 30	6 19 00	1 45	7 58	11.8	5.4
	Cape Trafalgar: Lighthouse	36 10 50	6 02 08	....	....	....	....
	Tarifa: Lighthouse	35 59 53	5 36 31	1 32	7 52	5.6	2.6
	Algeciras: Verde I. light	36 07 19	5 26 12	....	....	....	....
	Gibraltar: Dockyard flagstaff	36 07 10	5 21 17	....	....	....	....
	Europa Pt. light	36 06 25	5 20 42	1 35	7 55	3.7	1.7

COASTS OF THE MEDITERRANEAN, ADRIATIC, AND BLACK SEAS.

Spain.	Malaga: Lighthouse	36 42 39	4 24 38	2 15	8 35	2.9	1.5
	Almeria: Lighthouse	36 50 12	2 27 50	....	....	....	....
	Cape de Gata: Lighthouse	36 42 57	2 11 12	....	....	....	....
	Mazarron: Lighthouse	37 33 28	1 15 12	....	....	....	....
	Cartagena: Arsenal gate	37 35 50	0 59 09	....	....	....	....
	Escombrera light	37 33 22	0 57 58	....	....	....	....
	Porman: Lighthouse	37 34 38	0 50 20	....	....	....	....
	Santa Pola Bay: Lighthouse	38 12 30	0 30 12	....	....	....	....
	Alicante: N. mole light	38 20 12	0 28 48	....	....	....	....
	Villajoyose: Lighthouse	38 30 00	0 11 42	....	....	....	....
	Benidonne: Tower	38 30 57	0 10 06	....	....	....	....
	Altea: Lighthouse	38 33 30	0 04 02	....	....	....	....
			Long. E.				
	Calpe: Church tower	38 38 36	0 02 52	....	....	....	....
	Morayva: Tower	38 40 51	0 09 17	....	....	....	....
	Jarea: Cape San Antonio light	38 48 06	0 12 02	....	....	....	....
	Denia: Mole-head light	38 51 00	0 07 30	....	....	....	....
			Long. W.				
	Cape Cullera: Lighthouse	39 12 15	0 13 37	....	....	....	....
	Valencia: Lighthouse	39 28 05	0 19 48	....	....	....	....
	Mole-end light	39 27 50	0 18 50	5 00	11 30	1.5	0.8
			Long. E.				
	Columbretes Islands: Lighthouse	39 53 57	0 41 19	....	....	....	....
	Oropesa Cape: Lighthouse	40 04 53	0 08 56	....	....	....	....
	Vinaroz: Mole-head light	40 27 48	0 28 48	....	....	....	....
	Port Alfaques: Baña light	40 33 30	0 39 45	....	....	....	....
	Cape Tortosa: Lighthouse	40 43 10	0 53 55	....	....	....	....
	Tarragona: E. mole light	41 06 00	1 14 42	....	....	....	....
	Barcelona: Royal Academy Obsy	41 25 18	2 07 00	....	....	....	....
	Palamos Bay: Molino Pt. light	41 50 04	3 08 28	....	....	....	....
	Cadaques: Clock tower	42 16 15	3 17 10	....	....	....	....
	Cape Creux: Lighthouse	42 19 10	3 18 55	....	....	....	....

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

COASTS OF THE MEDITERRANEAN, ADRIATIC, AND BLACK SEAS—Continued.

Coast.	Place.	Lat. N.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
France.	Cape Bear: Lighthouse	42 30 59	3 07 30				
	Port Vendres: Fort Fanal light	42 31 18	3 06 50				
	Port Nouvelle: S. jetty light	43 00 47	3 04 08				
	Cette: Light, St. Louis mole	43 23 50	3 42 08				
	Aigues Mortes: Espignette Pt. light	43 29 17	4 08 32				
	Planier Rock: Lighthouse	43 11 57	5 13 51				
	Marseilles: Janet Cliff light	43 20 43	5 20 46	7 31	2 00	0.6	0.3
	National observatory	43 18 18	5 23 39				
	Ciotat: Berouard mole light	43 10 21	5 36 42				
	Toulon: St. Mandrien light	43 05 10	5 56 06	8 22	2 24	0.6	0.2
	Grand Riband Island: Lighthouse	43 01 01	6 08 39				
	Cannes: Lighthouse	43 32 51	7 00 54				
	Antibes: Garoupe light	43 33 51	7 08 02				
	Nice: Lighthouse	43 41 32	7 17 15				
	Villefranche: Mole-head light	43 41 58	7 18 42				
	Cape Ferret light	43 40 30	7 19 41				
Bal. I.	Port Ibiza: Lighthouse	38 54 10	1 27 25				
	Cabrera Island: Lighthouse	39 06 34	2 57 20				
	Pi (Majorca): Lighthouse	39 33 00	2 37 00				
	Port Mahon (Minorca): Lighthouse	39 51 53	4 18 20				
Sardinia.	Carloforte: Int. Latitude Obsy	37 08 09	8 18 44				
	Cape Spartivento: Lighthouse	38 52 34	8 51 08				
	Cape Sandalo: Light on San Pietro I	39 08 44	8 13 29				
	Porte Conte: Cape Caccia light	40 33 50	8 10 00				
	Port Torres: Lighthouse	40 50 25	8 23 56				
	Cape Testa: Lighthouse	41 14 36	9 08 42				
	Razzoli Island: Lighthouse	41 18 24	9 20 28				
	Caprera Island: Galera Pt	41 14 15	9 29 40				
	Cape Figari: Signal station	40 59 52	9 39 14				
	Cape Tavolara: Lighthouse	40 54 55	9 44 22				
	Cape Bellavista: Lighthouse	39 55 47	9 42 52				
	Cape Carbonera: Cavoli I. light	39 05 15	9 32 35				
	Cagliari: Light on mole	39 12 35	9 07 20				
Corsica.	Bonifacio: Mount Pertusato light	41 22 10	9 11 15				
	Ajaccio: Lighthouse	41 52 50	8 35 45				
	Corti: Church tower	42 18 14	9 09 04				
	Calvi: Lighthouse	42 35 10	8 43 25				
	Cape Corso: Giraglia I. light	43 01 45	9 24 10				
	Bastia: Lighthouse	42 41 47	9 27 00				
	Porto Vecchio: Chiape Pt. light	41 35 45	9 22 05				
Italy.	Cape Melle: Lighthouse	43 57 17	8 10 22				
	Genoa: San Benigno light	44 24 15	8 54 19				
	Hydro. Institute Obsy	44 25 09	8 55 20				
	Spezzia: Fort Santa Maria light	44 04 00	9 50 48				
	Florence: Arcetri Observatory	43 45 15	11 15 20				
	Leghorn (Livorno): Light on S. end of curved breakwater	43 32 36	10 17 45				
	Capraia Island: Cape Ferrajone light	43 02 57	9 51 07				
	Elba Island, Porto Longone: Cape Forcado light	42 45 14	10 24 38				
	Pianosa Island: Light on battery, W. side of fort	42 35 06	10 05 50				
	Africa Rock: Lighthouse	42 21 28	10 03 54				
	Monte Christo Islet: Summit	42 20 15	10 18 39				
	Giglio Island, Cape Rosso: Lighthouse	42 19 13	10 55 24				
	Civita Vecchia: Light N. end of breakwater	42 05 38	11 46 50				
	Rome: Royal Observatory at Capitol	41 53 34	12 29 06				
	Gaeta: Orlando tower	41 12 27	13 35 15				

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

COASTS OF THE MEDITERRANEAN, ADRIATIC, AND BLACK SEAS—Continued.

Coast.	Place.	Lat. N.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	*h. m.*	*h. m.*	*ft.*	*ft.*
Italy.	Ponza Islet: Punto della Guardia light	40 52 38	12 57 17	......	......	......	......
	Naples: Observatory, Capo di Monte	40 51 46	14 15 26	......	......	......	......
	Light on elbow of mole	40 50 20	14 15 37	4 00	10 13	0.7	0.2
	Capri Island: Carena Pt. light	40 32 07	14 11 40	......	......	......	......
	Lipari Island: Casa Bianca light	38 28 43	14 51 40	......	......	......	......
	Ustica Island: NE. point light	38 42 40	13 12 00	......	......	......	......
	Faro of Messina: Capo di Faro light	38 16 02	15 39 11	......	......	......	......
	Milazzo: Lighthouse	38 16 10	15 13 42	......	......	......	......
	Palermo: Royal Observatory	38 06 44	13 21 29	......	......	......	......
	Light on mole head	38 07 56	13 22 29	......	......	......	......
	Trapani: Palumbo Rock light	38 00 39	12 29 50	......	......	......	......
	Maritimo Island: Light on SW. pt	37 57 13	12 02 55	......	......	......	......
	Marsala: W. mole light	37 47 10	12 25 59	......	......	......	......
	Girgenti: Port Empedoche light	37 16 55	13 32 27	......	......	......	......
	Gozo Island: Light on NW. pt	36 04 10	14 12 55	......	......	......	......
	Malta Island, Valetta Harbor: Lighthouse	35 54 00	14 31 30	3 12	9 25	0.7	0.2
	Linosa Island: Landing Cove	35 51 50	12 52 09	......	......	......	......
	Lampedusa Island: Carallo Bianco light	35 29 37	12 36 12	......	......	......	......
	Cape Passaro: Lighthouse	36 41 03	15 07 45	......	......	......	......
	Syracuse: Maniace Castle light	37 03 04	15 17 37	......	......	......	......
	Augusta Port: Torre d'Avola light	37 12 39	15 13 20	3 00	9 13	0.9	0.3
	Catania: Sciari Biscari light	37 29 35	15 05 19	......	......	......	......
	Royal University Observatory	37 30 13	15 05 00	......	......	......	......
	Cape Taormina: Semaphore	37 50 25	15 18 30	......	......	......	......
	Messina: San Ranieri light	38 11 32	15 34 33	......	......	......	......
	Cape Peloro: Lighthouse	38 16 03	15 39 15	......	......	......	......
	Cape Spartivento: Lighthouse	37 55 27	16 03 45	......	......	......	......
	Cape Colonna: Lighthouse	39 01 29	17 12 09	......	......	......	......
	Cotrone: Mole-head light	39 04 38	17 08 07	......	......	......	......
	Taranto: Cape St. Vito light	40 24 41	17 12 23	......	......	......	......
	Gallipoli: St. Andrea light	40 02 48	17 56 55	......	......	......	......
	Cape Sta. Maria di Leuca: Lighthouse	39 47 43	18 22 17	......	......	......	......
	Cape Otranto: Lighthouse	40 06 23	18 31 25	......	......	......	......
	Port Otranto: Castle	40 09 06	18 28 45	......	......	......	......
	Brindisi: Lighthouse	40 39 36	17 59 37	3 30	9 43	1.8	0.5
	Bari: St. Catalolo light	41 08 19	16 50 52	......	......	......	......
	Viesti: Light on St. Croce Rock	41 53 17	16 11 13	......	......	......	......
	Manfredonia: Lighthouse	41 37 39	15 55 34	......	......	......	......
	Tremiti Islands: Caprara I. light	42 08 14	15 31 36	......	......	......	......
	Ancona: Monte Cappucini light	43 37 14	13 31 18	......	......	......	......
	Malamocco: Rocchetta Mole light	45 20 30	12 19 09	10 15	4 45	3.3	0.9
	Venice: Site of tower of St. Mark	45 26 02	12 20 24	......	......	......	......
	Nautical Institute Observatory	45 26 11	12 20 32	......	......	......	......
Austria.	Grado: Church tower	45 41 06	13 22 54	......	......	......	......
	Monfalcone: Church tower	45 48 33	13 32 10	......	......	......	......
	Trieste: Imperial Maritime Observatory	45 38 45	13 45 44	......	......	......	......
	Theresa Mole light	45 38 54	13 45 14	9 20	3 50	2.0	0.6
	Capo d'Istria: Lighthouse	45 33 00	13 43 18	......	......	......	......
	Isola: Lighthouse	45 32 34	13 39 32	......	......	......	......
	Pirano: Lighthouse	45 31 54	13 33 48	......	......	......	......
	Salvore Point: Lighthouse	45 29 24	13 29 30	......	......	......	......
	Citta Nuova: Lighthouse	45 19 16	13 33 42	......	......	......	......
	Parenzo: Cathedral tower	45 13 45	13 35 39	......	......	......	......
	Rovigno: St. Eufemia light	45 05 00	13 38 00	......	......	......	......
	Pola: Imperial Hydro. Office Obsy	44 51 49	13 50 43	9 00	3 25	3.4	0.9
	Promontore Point: Porer Rock light	44 45 30	13 53 36	......	......	......	......
	Nera Point: Lighthouse	44 57 24	14 08 42	......	......	......	......
	Fiume: Cathedral tower	45 19 36	14 26 41	8 15	2 35	1.2	0.3
	Porto Re: Lighthouse	45 16 18	14 33 42	......	......	......	......
	Veglia: Mole head	45 01 30	14 34 36	......	......	......	......
	Prestenizza Point: Lighthouse	45 07 12	14 16 30	......	......	......	......
	Cherso: Kimen Point light	44 57 36	14 23 30	......	......	......	......

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

COASTS OF THE MEDITERRANEAN, ADRIATIC, AND BLACK SEAS—Continued.

Coast.	Place.	Lat. N.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Austria.	Galiola Rock: Lighthouse	44 43 36	14 10 36				
	Unie Island: Netak Point light	44 37 20	14 14 06				
	Lussin Piccolo: Manora Observatory	44 32 11	14 28 06	8 10	2 25	1.1	0.3
	St. Pietro di Nembo Island: Health office.	44 27 42	14 33 28				
	Gruizza Rock: Lighthouse	44 24 42	14 34 06				
	Zengg: Mole-head light	44 59 24	14 53 48				
	Terstenik Rock: Lighthouse	44 40 06	14 34 42				
	Carlobago: Lighthouse	44 31 30	15 04 24				
	Zara: Church tower	44 07 05	15 14 05				
	Bianche Point: Lighthouse	44 09 06	14 49 24				
	Zara Vecchia: Church tower	43 56 16	15 26 21				
	Port Tajer: Lestrice I. light	43 51 15	15 12 06				
	Lucrietta Island: Lighthouse	43 37 36	15 34 24				
	Sebenico: Mount Tartaro	43 45 08	15 58 07	6 10	0 20	1.0	0.3
	Rogosnizza Port: Mulo Rock light	43 31 00	15 55 00				
	Zirona Grande Island: St. George Church tower	43 27 00	16 08 51				
	Trani: Cathedral tower	43 31 02	16 15 09				
	Port Spalato: Cathedral tower	43 30 07	16 26 06				
	Solta I., Port Olivetto: St. Nicholas tower	43 23 50	16 11 10				
	Spalato Passage: Speo Pt. light	43 19 12	16 24 30				
	Makarska: Church tower	43 17 46	17 01 36				
	Pomo Rock: Center	43 05 28	15 27 30				
	St. Andrea Rock: Summit	43 01 43	15 45 29				
	Lissa Island: Hoste Rock light	43 04 30	16 12 28	4 00	10 30	2.4	0.7
	Pakonjidol Rock: Lighthouse	43 09 24	16 27 14				
	Lesina Island: Port Gelsa light	43 09 50	16 41 55				
	St. Giorgio Pt. light	43 07 30	17 12 00				
	Sabioncello Peninsula: Cape Gomena light	43 02 50	17 00 19				
	Sorelle Rocks: Lighthouse	42 57 42	17 12 44				
	Curzola Island: Porto Bema mole head.	42 54 19	16 51 32				
	Porto Valle Grande, church tower	42 57 37	16 43 07				
	Lagostini Island: Glavat Rock light	42 45 54	17 08 54				
	Lagosta Island: St. George Chapel	42 45 05	16 51 45				
	Cazza Island: Lighthouse	42 45 05	16 29 29				
	Pelagosa Rock: Lighthouse	42 23 30	16 15 12				
	Meleda Island: Port Palazzo Ruin	42 47 06	17 22 51				
	Olipa Rock: Lighthouse	42 45 30	17 46 48				
	Pettini di Ragusa Rocks: Lighthouse	42 39 00	18 03 08				
	Bobara Rock: Summit	42 35 08	18 10 49				
	Molonta Peninsula: Summit	42 27 04	18 25 36				
	Ostro Point: Lighthouse	42 23 36	18 32 00				
	Cattaro: Health office	42 25 30	18 46 12				
	Budua: Mole-head light	42 16 42	18 50 36				
	Katic Rock: St. Domenica Chapel	42 11 43	18 56 25				
	Antivari: Pt. Valovica light	42 05 15	19 04 19				
	Dulcigno: W. windmill	41 55 47	19 12 29				
Albania.	Cape Rodoni: Guardhouse	41 35 10	19 27 15				
	Cape Pali: Guardhouse	41 23 31	19 24 54				
	Durazzo: Lighthouse	41 18 40	19 27 14				
	Cape Laghi: Ruin	41 08 44	19 26 47				
	Skumbi River: Pyramid at mouth	41 02 12	19 26 30				
	Semeny River: Samana Pt. light	40 47 00	19 20 14				
	Vojazza River: Pyramid at mouth	40 36 14	19 19 14				
	Avlona: Lighthouse	40 25 30	19 27 55				
	Cape Linguelta: Extreme	40 25 17	19 17 45				
	Mount Cica: Pyramid	40 12 00	19 38 33				
	Port Palermo: Pyramid	40 02 57	19 47 53				
	Cape Kiefali: Pyramid	39 54 29	19 54 55				

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

COASTS OF THE MEDITERRANEAN, ADRIATIC, AND BLACK SEAS—Continued.

Coast.	Place.	Lat. N.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		′ ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Greece.	Saseno Island: Lighthouse	40 30 12	19 16 15				
	Fano Island: Pt. Kastri light	39 51 53	19 26 06				
	Port Pagonia: Ruin	39 39 27	20 07 12				
	Port Gomenitza: Well Dogana	39 29 50	20 17 09				
	Port Parga: Madonna I	39 16 32	20 24 55				
	Port St. Spiridione: Convent	39 39 54	19 43 09				
	Corfu: Lighthouse	39 37 05	19 56 30				
	Paxo Island: Madonna I. light	39 11 30	20 12 34				
	Prevesa; Fort Nuovo minaret	38 56 30	20 45 40				
	Port Drepano: Observation island	38 47 25	20 44 16				
	Port Vliko: Customhouse	38 40 40	20 42 44				
	Port Vathi: Lazaretto light	38 22 04	20 43 37				
	Port Argostoli: St. Theodoro light	38 11 36	20 29 30				
	Patras: Lighthouse	38 15 00	21 43 50	3 40	9 53	1.0	0.3
	Katakolo: Lighthouse	37 38 20	21 18 55				
	Zante: Mole light	37 47 10	20 55 26				
	Strovathi, or Strivali Island: Stamphani I. light	37 15 12	21 01 14				
	Proti Passage: Marathon Pt	37 03 38	21 34 35				
	Navarin: Lighthouse	36 54 10	21 40 29				
	Mothoni: Round tower	36 48 40	21 42 40				
	Koroni Anchorage: Mole light	36 47 50	21 58 00				
	Petalidi Bay: Petalidi Pt	36 57 20	21 56 42				
	Candia Island, Port Suda: Lighthouse	35 28 55	24 09 39				
	Megalo Kastron: Mole light	35 20 30	25 09 44				
	Kandeliusa Island: Lighthouse	36 29 40	26 59 25				
	Stampali Island, Maltezana Port: Agios Ioanes	36 34 25	26 24 28				
	Christiana Islands: N. pt	36 15 20	25 13 00				
	Milo Island: Summit, Mt. St. Elias	36 40 27	24 23 15				
	Siphano Island: Lighthouse	36 59 12	24 40 30				
	Naxos Island, Naxia: Gate on Bacchus I	37 06 32	25 23 00				
	Paros Island, Port Trio: Trio Pt	37 00 01	25 14 21				
	Port Naussa: St. Yanni Church	37 08 38	25 14 08				
	Syra: Mole light	37 26 12	24 56 14				
	Sermo Island: Amyno Pt	37 07 36	24 32 23				
	Thermia Island: Ruins of Cythnus	37 25 55	24 23 35				
	Jura Island: North pt	37 38 00	24 44 32				
	Port St. Nikolo: Lighthouse	37 39 28	24 19 44				
	St. Nikalao Island: Port Mandri	37 44 00	24 04 12				
	Andros Island, Cape Fasse: Lighthouse	37 57 30	24 42 30				
	Ieraka: Acropolis	36 47 05	23 05 40				
	Port Kheli: Lighthouse	37 18 42	23 08 53				
	Poros Island: Lighthouse	37 31 45	23 25 45				
	Ægina: Lighthouse	37 44 30	23 25 30				
	Piræus: Lighthouse	37 56 14	23 38 10				
	Athens: National Observatory	37 58 21	23 43 14				
	Cape Colonna: Extreme	37 38 45	24 02 15				
	Port Raphti: Statue I	37 52 48	24 03 00				
	Petali Island: Trago I. peak	38 01 28	24 16 42				
	Euripo Strait: Lighthouse	38 28 15	23 36 45				
	Skiathos Island: Mount Stavros	39 10 48	23 27 07				
	Salonika: S. bastion	40 37 28	22 58 00				
	Lemnos Island: Kastro Castle	39 52 10	25 03 20				
	Port Moudros: Sangrada Pt	39 50 52	25 14 14				
	Strati Island: St. Strati Church	39 31 58	24 59 13				
	Mityleni Island, Port Sigri: Lighthouse	39 12 35	25 50 00				
	Mityleni: Light on Mityleni Pt	39 06 10	26 34 54				
	Port Iero: Sidero Islet	39 03 20	26 31 39				
	Psara Island: Fort	38 32 00	25 35 00				

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

COASTS OF THE MEDITERRANEAN, ADRIATIC, AND BLACK SEAS—Continued.

Coast.	Place.	Lat. N.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Turkey.	Port Baklar: Cape Xeros	40 32 40	26 45 00	......	......	......	....
	Port Isene: Tower	37 16 33	27 36 55	......	......	......	....
	Samos Island: Fonia Pt. light	37 41 24	26 58 42	......	......	......	....
	Tchesmé: C. Kécil light	38 19 55	26 17 45	......	......	......	....
	Kos: Lighthouse	36 55 00	27 18 25	......	......	......	....
	Marmorice Harbor: Adassi Pt. light	36 48 00	28 18 00	......	......	......	....
	Makry Harbor: Kasil I	36 39 33	29 06 13	......	......	......	....
	Rhodes Port: Arab's Tower light	36 26 00	28 16 24	......	......	......	....
	Port Lindo: Tower	36 05 53	28 08 10	......	......	......	....
	Dardanelles: Hellas Pt. light	40 02 30	26 10 54	......	......	......	....
	Gallipoli: Lighthouse	40 24 27	26 41 24	......	......	......	....
	Bosphorus: Tofana Pt. light	41 01 20	29 01 00	......	......	......	....
	Scutari: Leander Tower light	41 01 02	29 00 29	......	......	......	....
	Constantinople: Seraglio Pt. light	41 00 35	29 01 14	......	......	......	....
	St. Sophia Mosque	41 00 16	28 58 59	......	......	......	....
	Cape Kara Burnu: Lighthouse	41 21 15	28 42 14	......	......	......	....
Russia.	Yuiada Road: Fort Tersana	41 52 04	27 58 45	......	......	......	....
	Burghaz: Lighthouse	42 27 52	27 35 54	......	......	......	....
	Varna Bay: Lighthouse	43 10 00	27 58 35	......	......	......	....
	Kusterjeh: Cape Kusterjeh light	44 10 20	28 39 14	......	......	......	....
	Danube River: Salina light	45 09 47	29 41 14	......	......	......	....
	Fidonisi Island: Lighthouse	45 16 00	30 14 14	......	......	......	....
	Odessa: University Observatory	46 28 37	30 45 32	......	......	......	....
	Nikolaieff: Naval Observatory	46 58 22	31 58 27	......	......	......	....
	Dnieper Bay: Fort Nikolaeo light	46 34 27	31 33 36	......	......	......	....
	Sebastopol: E. lighthouse	44 36 55	33 36 26	......	......	......	....
	Balaklava Bay: Hospital	44 29 50	33 36 25	......	......	......	....
	Kertch: Lighthouse	45 21 03	36 28 30	......	......	......	....
	Berdiansk: Breakwater light	46 45 00	36 46 40	......	......	......	....
	Saukhoum: Lighthouse	42 58 00	40 55 10	......	......	......	....
Turkey.	Batoum: Lighthouse	41 39 30	41 38 15	......	......	......	....
	Trebizond: Lighthouse	41 01 00	39 46 25	......	......	......	....
	Sinope: Lighthouse	42 01 20	35 13 20	......	......	......	....
	Bender Erekli: Lighthouse	41 18 03	31 25 49	......	......	......	....
	Marmora Island: Light off E. pt	40 38 10	27 46 09	......	......	......	....
	Artaki Bay: Zeitijn Adasi Islet	40 23 30	27 47 30	......	......	......	....
	Tenedos Island: Ponente Pt. light	39 50 00	25 58 34	......	......	......	....
	Port Ajano: Nikolo Rock	39 01 21	26 47 57	......	......	......	....
	Port Ali-Agha: W. pt. of entrance	38 50 10	26 57 20	......	......	......	....
	Smyrna: English consulate flagstaff	38 25 40	27 09 10	9 15	3 15	2.5	0.7
	Vourlah: Customhouse	38 21 48	26 47 00	......	......	......	....
	Sighajik Harbor: Beacon on islet	38 12 21	26 47 32	......	......	......	....
	Budrum: Lighthouse	37 02 00	27 27 05	......	......	......	....
	Adalia: Lighthouse	36 52 00	30 45 34	......	......	......	....
	Alexandretta: Lighthouse	36 35 30	36 10 20	......	......	......	....
	Latakia: Lighthouse	35 30 30	35 46 30	......	......	......	....
	Tripoli Roadstead: Bluff Islet light	34 29 25	35 44 24	......	......	......	....
	Ruad Island: Lighthouse	34 52 00	35 51 00	......	......	......	....
	Beirut: Lighthouse	33 54 10	35 28 25	9 45	3 35	1.2	0.3
	Saida (ancient Sidon): Lighthouse	33 34 20	35 21 30	......	......	......	....
	Sûr (ancient Tyre): Lighthouse	33 16 30	35 14 40	......	......	......	....
	Acre: Lighthouse	32 54 35	35 08 00	......	......	......	....
	Haifa: Lighthouse	32 47 40	35 05 00	......	......	......	....
Cyprus.	Famagusta: Lighthouse	35 07 10	33 57 22	9 40	3 30	1.4	0.4
	C. Gata: Light	34 33 45	33 01 30	......	......	......	....
	Lamaka: Lighthouse	34 54 00	33 38 59	......	......	......	....
Egypt.	Port Said: High lighthouse	31 15 41	32 18 45	9 40	3 30	1.0	0.3
	River Nile: Damietta Mouth	31 31 40	31 51 00	......	......	......	....
	Rosetta Mouth light	31 29 30	30 19 10	......	......	......	....
	Aboukir Bay: Nelson I. peak	31 21 23	30 06 00	......	......	......	....
	Alexandria: Eunostos Pt. light	31 11 43	29 51 40	9 45	3 15	1.1	0.3

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

COASTS OF THE MEDITERRANEAN, ADRIATIC, AND BLACK SEAS—Continued.

Coast.	Place.	Lat. N.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
	Ben Ghazi: Castle	32 06 51	20 02 40	9 55	3 45	1. 2	0. 3
	Tripoli Harbor: Lighthouse	32 54 03	13 10 50	10 00	3 50	1. 9	0. 5
Tunis.	Sfax: Ras Tina light	34 39 01	10 41 17	3 35	9 57	4. 2	1. 1
	Mehediah: Sidi Jubber	35 30 24	11 05 15				
	Monastir: Burj el Kelb battery	35 45 24	10 50 42				
	Hammamet Bay: Castle flagstaff	36 23 20	10 37 10				
	Kalibia Road: Lighthouse	36 50 12	11 07 00				
	Cape Bon: Lighthouse	37 04 45	11 03 15				
	Tunis: Goletta light	36 48 19	10 18 31	3 33	9 55	3. 0	0. 8
Algeria.	Cape Farina: Extreme	37 10 42	10 17 30				
	Benzert: N. Jetty light	37 16 38	9 53 21				
	Galita Island: Monte Guardia	37 31 16	8 56 12				
	Bona: Fort Genois light	36 57 15	7 46 40				
	Stora: Singe I. light	36 54 29	6 53 11				
	Cape Bougaroni: Lighthouse	37 05 17	6 28 37				
	Cape Carbon: Lighthouse	36 46 41	5 06 22				
	Algiers: Lighthouse near Admiralty	36 47 16	3 04 13	2 46	8 58	2. 6	1. 3
	Bouzareah Observatory	36 47 50	3 02 08				
	Cape Tenez: Lighthouse	36 33 07	1 20 36				
			Long. W.				
	Oran: Mers el Kebir light	35 44 21	0 41 38				
	Habibas Island: Lighthouse	35 43 22	1 07 57				
Morocco.	Zafarin Islands: Light Isabel Segunda I.	35 11 05	2 25 45				
	Alboran Island: Lighthouse	35 58 00	3 03 29				
	Ceuta: Lighthouse	35 53 44	5 16 46	1 55	8 07	3. 3	1. 5
	Tangier: Casbah tower	35 47 00	5 48 31	1 30	7 40	8. 0	3. 7
	Cape Spartel: Lighthouse	35 47 14	5 55 41				

WEST COAST OF AFRICA.

Coast.	Place.	Lat. N.	Long.	H. W.	L. W.	Spg.	Neap.
	El Araish: S. pt. of entrance	35 12 50	6 09 13				
	Sali: Fort	34 04 10	6 48 00	1 35	7 45	10. 4	4. 8
	Cape Dar el Beida: Lighthouse	33 36 00	7 33 00				
	Cape Blanco, North: Extreme	33 08 00	8 35 05				
	Mogador Harbor: English consulate	31 30 30	9 43 30	1 05	7 17	10. 9	5. 0
	Cape Ghir: Extreme	30 38 00	9 50 00				
	Cape Noun: Extreme	28 45 00	11 02 00				
	Cape Juby: Extreme	27 56 00	12 56 00	11 55	5 43	8. 5	3. 9
	Cape Bojador: Extreme	26 07 57	14 29 00	11 50	5 38	7. 3	3. 4
	Penha Grande	25 07 06	14 50 44				
	Ouro River entrance: Dumford Pt	23 36 03	15 58 00				
	Pedra de Galha	22 12 37	16 48 11				
	Cape Blanco: Extreme	20 46 27	17 05 40	11 35	5 23	5. 5	2. 5
	Portendik: Village	18 18 45	16 02 00				
	St. Louis: Lighthouse	16 01 31	16 30 22				
	Almadie Point: Lighthouse	14 44 45	17 32 25				
	Cape Verde: Lighthouse	14 43 20	17 30 55				
	Port Dakar: Lighthouse	14 40 30	17 25 28				
	Cape Manoel: Lighthouse	14 38 55	17 26 47				
	Goree Island: Fort	14 39 55	17 24 30				
	Bird Island: Flagstaff	13 39 45	16 40 30				
	Bathurst: Flagstaff	13 28 00	16 35 00	9 00	2 50	5. 9	2. 7
	Carabane: Lighthouse	12 35 00	16 44 00				
	Nunez River: Sand I	10 36 37	14 42 00				
	Ponga River entrance: Observation Pt	10 03 15	14 04 30	7 30	1 20	11. 4	5. 2
	Isles do Los: Lighthouse	9 30 30	13 44 00				
	Matacong Island: House	9 16 10	13 26 20				
	Scarcies River: W. end of Yellaboi I	8 57 05	13 18 25				

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

WEST COAST OF AFRICA—Continued.

Coast.	Place.	Lat. N.	Long. W.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
	Sierra Leone: Light on cape	8 30 00	13 18 30	7 40	1 30	11.6	5.3
	N. battery	8 29 57	13 14 30	....	....	....	....
	Sherbro Island: N. island	7 40 36	13 04 30	....	....	....	....
	Sherbro River: Manna Pt	7 22 45	12 31 55	5 50	12 00	10.4	4.8
	Gallinas River: W. elbow of Kamasoun I.	7 00 08	11 38 45	....	....	....	....
	Cape Mount: W. peak	6 44 30	11 22 51	....	....	....	....
	Cape Mesurado: Lighthouse	6 19 10	10 49 25	....	....	....	....
	Monrovia: Lighthouse	6 19 00	10 50 00	5 40	11 54	6.0	2.5
	Marshall: Agent's house	6 08 06	10 22 45	....	....	....	....
	Grand Bassa: Agent's house	5 54 08	10 04 05	....	....	....	....
	Cestos: Factory	5 26 25	9 34 45	....	....	....	....
	Sangwin River: Sangwin Pt	5 12 42	9 20 16	....	....	....	....
	Sinon: Bloobarra Pt	4 59 15	9 02 05	4 50	11 05	4.8	2.0
	Cape Palmas: Lighthouse	4 22 10	7 44 15	4 30	10 43	4.3	1.8
	Tabou River: Tabou Pt	4 24 47	7 21 30	....	....	....	....
	Axim Bay: Ft. St. Anthony	4 52 18	2 14 45	....	....	....	....
	Cape Three Points: Lighthouse	4 45 00	2 05 45	4 00	10 13	4.7	1.9
	Dix Cove: Fort	4 47 45	1 56 40	....	....	....	....
	Tacorady Bay: Tacorady Pt	4 53 00	1 45 00	....	....	....	....
	Chama Bay: Dutch Fort	5 01 00	1 38 00	....	....	....	....
	El Mina Bay: Ft. St. George	5 04 48	1 21 05	....	....	....	....
	Cape Coast Castle: Lighthouse	5 06 20	1 13 50	4 20	10 32	6.0	2.5
	Accra: Lighthouse	5 31 50	0 11 30	....	....	....	....
			Long. E.				
	Volta River entrance: Dolbens Pt	5 46 00	0 41 00	4 20	10 33	4.2	1.8
	Lagos River: Lighthouse	6 25 15	3 25 15	4 50	11 05	3.3	1.3
	Benin River entrance: N. pt	5 46 01	5 03 05	....	....	....	....
	Brass River: Entrance (approx.)	4 16 40	6 15 00	....	....	....	....
	Calebar River (New): Rough Corner	4 23 07	7 07 00	....	....	....	....
	Opobo River: W. pt. beacon (approx.)	4 27 00	7 40 00	....	....	....	....
	Quaebo River: Bluff Pt	4 30 40	7 59 00	....	....	....	....
	Calebar River (Old): Judicial Ho. flagstaff (Duke Town)	4 57 53	8 18 57	....	....	....	....
	Fernando Po Island: Lighthouse	3 46 10	8 47 05	....	....	....	....
	San Bento River: Joho Pt. (approx.)	1 35 00	9 39 00	....	....	....	....
	Princes Island: Diamond Rocks, center of largest	1 40 42	7 27 56	....	....	....	....
	St. Thomas Island: Ft. San Sebastian light	0 20 30	6 42 45	....	....	....	....
		Lat. S.					
	Anno Bon Island: Turtle Islet	1 24 18	5 38 12	....	....	....	....
	Cape Lopez: Lighthouse	0 36 25	8 43 10	....	....	....	....
	Mayumba Bay: Lighthouse	3 23 00	10 38 00	4 25	10 38	7.0	2.9
	Loango Bay: Indian Pt. light	4 40 00	11 46 30	4 13	10 26	6.5	2.7
	Black Point Bay: Sandy Pt	4 49 00	11 45 00	....	....	....	....
	Malemba Bay: Landing Cove	5 18 30	12 08 00	....	....	....	....
	Kabenda Bay: Kabenda Pt. light	5 32 30	12 11 00	....	....	....	....
	Congo River entrance: Shark Pt	6 04 36	12 15 00	4 10	10 25	6.0	2.5
	Margate Head: Summit	6 31 50	12 25 25	....	....	....	....
	St. Paul de Loando: Flagstaff, Ft. San Miguel	8 48 24	13 13 20	3 40	9 53	4.8	2.0
	Lobito Point: Extreme	12 20 00	13 32 00	....	....	....	....
	Benguela: Telegraph office	12 34 43	13 23 45	3 30	9 43	5.5	2.3
	Elephant Bay: Friar Rocks	13 12 30	12 48 55	....	....	....	....
	St. Mary Bay: Bay I	13 26 05	12 36 00	....	....	....	....
	Little Fish Bay: Lighthouse	15 09 00	12 12 00	....	....	....	....
	Port Alexander: Bateman Pt	15 47 30	11 52 40	....	....	....	....
	Great Fish Bay: Tiger Pt	16 30 00	11 42 00	3 00	9 12	5.7	2.4
	Cape Frio: Extreme	18 23 00	11 57 12	....	....	....	....
	Walfisch Bay: Lighthouse	22 57 00	14 30 00	....	....	....	....
	Ichabo Island	26 17 00	14 57 20	....	....	....	....
	Angra Pequena: Diaz Pt	26 37 52	15 07 02	....	....	....	....
	Elizabeth Bay: S. pt. of Possession I	26 58 30	15 12 22	2 35	8 47	5.5	2.3

MARITIME POSITIONS AND TIDAL DATA.

WEST COAST OF AFRICA—Continued.

Coast.	Place.	Lat. S.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
	North Nolloth: Magistrate's house	29 15 12	16 52 02	2 25	8 38	5.3	2.2
	Hondeklip Bay	30 18 33	17 16 20	......	......	......	.....
	Roodewal Bay	30 33 07	17 27 30	......	......	......	.....
	Saldanha Bay: Constable Hill	33 07 51	18 01 21	2 20	8 33	5.1	2.1
	Table Bay: Robben I. light	33 48 52	18 22 33	......	......	......	.....
	Cape Town: Royal Observatory	33 56 04	18 28 41	1 36	7 47	4.6	2.0
	Cape of Good Hope: Lighthouse	34 21 12	18 29 26	......	......	......	.....

EAST COAST OF AFRICA AND THE RED SEA.

Coast.	Place.	Lat. S.	Long. E.	H. W.	L. W.	Spg.	Neap.
	Simons Bay: Lighthouse	34 10 45	18 27 30	2 35	8 48	5.2	2.2
	Cape Hangklip: Extreme	34 23 48	18 50 20	......	......	......	.....
	Quoin Point: Extreme	34 46 45	19 38 17	......	......	......	.....
	Cape Agulhas: Lighthouse	34 49 45	20 00 37	2 40	8 53	5.2	2.2
	Port Beaufort: Flagstaff	34 23 47	20 48 40	......	......	......	.....
	St. Blaize: Lighthouse	34 11 10	22 09 31	3 18	9 31	5.6	2.0
	Knysna Harbor: Fountain beacon	34 04 35	23 03 38	......	......	......	.....
	Plettenberg Bay: Summit of Seal Pt	34 06 15	23 24 23	......	......	......	.....
	St. Francis: Lighthouse	34 12 30	24 50 20	......	......	......	.....
	Cape Recife: Lighthouse	34 01 41	25 42 12	......	......	......	.....
	Port Elizabeth: Lighthouse	33 57 43	25 37 21	3 21	9 33	5.4	1.9
	Bird Islands: Lighthouse	33 50 27	26 17 13	......	......	......	.....
	Port Alfred: Signal staff	33 36 09	26 54 10	......	......	......	.....
	Waterloo Bay: Maitland Signal Hill	33 28 00	27 03 00	......	......	......	.....
	Madagascar Reef: Center	33 23 10	27 20 48	......	......	......	.....
	Cove Rock: Center	33 05 10	27 49 12	......	......	......	.....
	East London: Lighthouse	33 01 45	27 55 02	3 37	9 50	5.0	1.8
	Cape Morgan: Extreme	32 42 00	28 22 36	......	......	......	.....
	Hole-in-the-Wall	32 02 30	29 06 40	......	......	......	.....
	Rame Head: Extreme	31 48 15	29 21 15	......	......	......	.....
	Cape Hermes: Extreme	31 38 06	29 33 16	......	......	......	.....
	Waterfall Bluff	31 26 15	29 48 40	......	......	......	.....
	Port Natal (Durban): Lighthouse	29 52 40	31 03 41	3 58	10 11	5.6	1.6
	Govt. Observatory	29 50 47	30 00 18	......	......	......	.....
	Dumford Point: Extreme	29 00 12	31 51 39	......	......	......	.....
	Cape St. Lucia: Extreme	28 32 30	32 27 39	......	......	......	.....
	Cape Vidal: Extreme	28 09 36	32 38 10	......	......	......	.....
	Delagoa Bay: Pta. Vermelha (Reuben Pt.) light	25 58 30	32 35 55	5 10	11 22	11.9	3.4
	Cape Corrientes: Small rock	24 05 30	35 29 45	......	......	......	.....
	Innamban Bay: Barrow Hill light	23 45 30	35 31 41	4 30	10 42	11.0	3.2
	Cape St. Sebastian: Extreme	22 05 00	35 29 00	......	......	......	.....
	Bazaruto Island: N. pt. light	21 31 00	35 29 30	......	......	......	.....
	Chuluwan Island: Lighthouse	20 38 10	34 53 30	......	......	......	.....
	Sofala: Fort on N. side of entrance	20 10 42	34 46 00	......	......	......	.....
	Zambesi River: Kangoni Mouth	18 52 50	36 11 47	4 15	10 27	13.5	3.9
	Kiliman River: Lighthouse	18 01 24	36 58 30	......	......	......	.....
	Kiliman: Town	17 51 50	37 01 09	......	......	......	.....
	Mazemba River: Entrance	17 15 00	38 04 00	......	......	......	.....
	Premeira Islands: Center of Casuarina I.	17 06 30	39 06 27	......	......	......	.....
	Angoxa Islands: Center of Hurd I.	16 33 24	39 49 57	......	......	......	.....
	Mafamale Island: Center	16 20 30	40 03 57	......	......	......	.....
	Port Mokambo: Mokambo Pt.	15 08 00	40 36 12	......	......	......	.....
	Port Mozambique: St. George I. light	15 02 12	40 48 45	......	......	......	.....
	San Sebastian light	15 00 45	40 45 06	4 00	10 12	11.8	3.4
	Cape Cabeceira: Lighthouse	14 58 20	40 45 10	......	......	......	.....
	Port Conducia: Bar Pt.	14 53 00	40 40 00	......	......	......	.....
	Lurio Bay: Pando Pt.	13 23 40	40 46 00	......	......	......	.....
	Pemba Bay: N pt. light	12 55 45	40 31 15	......	......	......	.....
	Querimba Islands: Ibo I. light	12 19 30	40 40 09	......	......	......	.....
	Numba Island: E. pt.	11 09 18	40 43 21	......	......	......	.....

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

EAST COAST OF AFRICA AND THE RED SEA—Continued.

Coast.	Place.	Lat. S.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
	Cape Delgado: Lighthouse	10 41 20	40 38 35	3 59	10 11	11.3	3.3
	Msimbati: Ras Matunda	10 19 22	40 26 34				
	Mikindini Harbor: Kinizi	10 16 31	40 10 33				
	Mgan Mwania: Madjori Rock	10 06 43	40 02 14				
	Lindi River: Fort flagstaff	9 59 30	39 46 41	3 55	10 08	10.9	4.5
	Mchinga Bay: Observation spot	9 44 22	39 47 07				
	Kiswere Harbor: Rustmigi	9 25 36	39 39 31				
	Kilwa Kisiwani: Fort	8 57 15	39 30 42				
	Mafia Island: Moresby Pt	7 38 10	39 54 42				
	Dar-Es-Salaam: Flagstaff	6 49 41	39 17 05				
	Bagamoyo: French Mission	6 26 10	38 54 27				
	Zanzibar: English consulate	6 09 43	39 11 08	4 05	10 17	14.5	6.0
	Tanga Bay: Lighthouse	5 00 35	39 10 20				
	Mombasa: Lighthouse	4 04 30	39 41 13				
	Port Melinda: Vasco de Gama's Pillar	3 12 48	40 11 21	4 00	10 13	12.1	5.0
	Lamo Bay: Lamo Castle	2 15 42	40 56 21				
	Manda Roads: E. side of Manda Toto I.	2 13 35	40 59 40				
	Port Durnford: Foot Pt	1 13 00	41 54 15	4 30	10 42	11.7	4.9
	Kisimayu Bay: S. pt. of Kisimayu I	0 22 35	42 33 57				
		Lat. N.					
	Brava: Well	1 06 48	44 03 27	4 15	10 27	7.5	3.1
	Meurka Anchorage: S. pt. of town	1 42 06	44 53 49				
	Magadoxa: Tower	2 01 48	45 24 39				
	Murat Hill: Peak	2 30 00	46 07 00				
	Ras Hafun: E. extreme of Africa	10 26 30	51 22 55				
	Cape Guardafui: E. pt	11 50 30	51 16 45	6 00	12 12	6.1	2.5
	Kal Farun Islet: Center	12 26 00	52 09 35				
	Abd-al-Kuri Island: NE. pt	12 11 15	52 25 35				
	Sokotra Island: Tamarida, mosque	12 39 00	53 59 31	7 05	1 17	7.5	3.1
	Ras Antareh: Extreme of rocky pt	11 27 30	49 35 40				
	Mait Island: Center	11 13 00	47 17 00				
	Port Berbera: Lighthouse	10 25 00	44 59 35				
	Zeyla: Mosque	11 22 00	43 29 35	7 30	1 18	8.5	3.5
	Perim Island: Lighthouse	12 39 00	43 25 35	7 50	1 38	7.2	3.0
Red Sea.	Hanfelah Bay: Hanfelah Pt	14 44 00	40 52 00				
	Disei Island: Village Bay	15 28 10	39 45 30				
	Massaua Harbor: N. pt. of entrance	15 37 12	39 27 23	0 45	6 57	4.0	1.7
	Khôr Nowarat: Shatireh Islet	18 15 12	38 19 30				
	Suakin: Lighthouse	19 07 00	37 19 09	2 10	8 22	1.7	0.7
	Makaua Island: S. pt	20 44 00	37 15 30				
	St. Johns Island: Peak	23 36 20	36 10 15				
	Dædalus Shoal: Lighthouse	24 56 30	35 51 00				
	Kosair Anchorage: SW. angle of fort	26 06 24	34 17 03				
	Brothers Island: Lighthouse	26 18 50	34 50 45	6 40	0 28	2.0	0.8
	Safajah Island: N. summit	26 45 48	33 59 43				
	Ashrafi Island: Lighthouse	27 47 21	33 42 28				
	Ras Gharib: Lighthouse	28 20 52	33 06 31	10 35	4 23	1.5	0.6
	Zafarana: Lighthouse	29 06 29	32 39 43	10 40	4 28	5.5	2.3
	Suez: Newport Rock	29 53 05	32 32 50	10 45	4 32	6.8	2.8
	Tôr: Ruined fort	28 13 47	33 36 56				
	Sherm Yahar: Entrance	27 35 45	35 30 30				
	Sherm Joobbah: Entrance	27 33 00	35 32 30				
	Sherm Wej: Lighthouse	26 13 00	36 27 00				
	Sherm Hassey: Anchorage	24 38 35	37 17 45				
	Yembó: Anchorage	24 05 15	38 02 45				
	Sherm Rabegh: Anchorage	22 43 50	39 00 30				
	Jiddah: Jezirah el Mifsaka I	21 28 00	39 10 38	3 30	9 42	2.0	0.8
	Lith: Agha Islet	20 09 00	40 12 00				
	Jelalil: Anchorage	19 55 30	40 30 00				
	Kunfidah: Islet	19 07 40	41 03 20				
	Khôr Nohud: Entrance	18 15 50	41 27 30				

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

EAST COAST OF AFRICA AND THE RED SEA—Continued.

Coast.	Place.	Lat. N.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Red Sea.	Farisan I. Anchorage: Jebel Mandhakh	16 50 15	41 58 15	......	......	......	.....
	Gizau: Fort	16 53 00	42 29 00	......	......	......	.....
	Loheiya: Hill Fort	15 42 00	42 38 45	1 15	7 27	2.9	1.2
	Kamarán Bay: Harbor	15 20 30	42 34 00	......	......	......	.....
	Hodeïda Road	14 47 00	42 56 00	......	......	......	.....
	Jebel Zukur Island: N. pt	14 03 53	42 45 28	......	......	......	.....
	Mòkha: N. Fort	13 19 43	43 13 36	11 45	5 33	4.5	1.9

ISLANDS OF THE INDIAN OCEAN.

Coast.	Place.	Lat. N.	Long. E.	H. W.	L. W.	Spg.	Neap.
Laccadive Islands.	Chitlac Islet: S. end	11 40 45	72 42 54	......	......	......	.....
	Betrapar Islet: N. Island	11 35 00	72 09 54	......	......	......	.....
	Kittan Islet: S. end	11 27 30	72 59 00	10 20	4 00	6.3	3.0
	Cardamum Islet: Center	11 13 00	72 44 00	......	......	......	.....
	Ameni Islet: N. end	11 06 00	72 41 00	......	......	......	.....
	Underut Islet: Center	10 47 00	73 40 00	......	......	......	.....
	Cabrut Islet: E. end	10 32 00	72 37 40	......	......	......	.....
	Seuheli Par: N. islet	10 06 00	72 15 10	......	......	......	.....
	Kalpeni Islet: S. end	10 03 00	73 35 54	......	......	......	.....
	Minikoi Island: Lighthouse	8 16 00	73 01 15	11 27	5 15	2.5	1.2
Maldive Islands.	Heawandu Island: S. end	6 55 00	72 55 54	......	......	......	.....
	Kee-lah Island: N. end	6 59 00	73 12 54	......	......	......	.....
	Mah Kundu Island: NE. extreme	6 25 00	72 41 54	......	......	......	.....
	Nar Foree Island	5 26 30	73 20 00	......	......	......	.....
	Hee-tah-doo Island	5 01 30	72 53 00	......	......	......	.....
	To-du Island: Center	4 25 45	72 57 24	......	......	......	.....
	Gafor Island: Center	4 44 00	73 28 00	......	......	......	.....
	Malé, or Kings Island: Flagstaff	4 10 15	73 30 24	0.20	6 25	2.9	1.4
	Pha-li-du Island: Northern end	3 41 00	73 24 54	......	......	......	.....
	Moluk Island: Center	2 57 00	73 34 24	......	......	......	.....
	Himmittee Island	3 16 00	72 48 00	......	......	......	.....
	Kimbeedso Island: S. end	2 10 30	73 03 00	......	......	......	.....
	Esdu Island: NE. pt	2 07 00	73 35 54	......	......	......	.....
	Wahdu Island: E. end	0 14 30	73 13 00	......	......	......	.....
		Lat. S.					
	Addu Atoll: Gung I	0 41 30	73 06 54	......	......	......	.....
	Amirante Islands: Ile des Roches, N. beach	5 40 56	53 41 03	......	......	......	.....
	African Islands	4 52 26	53 23 38	......	......	......	.....
	Seychelles, Platte I.: S. end	5 53 00	55 27 10	......	......	......	.....
	Port Victoria: End of Hodoul Jetty	4 37 15	55 27 23	4 22	10 35	4.3	1.2
	Bird Island: Tree	3 43 06	55 12 19	......	......	......	.....
	Chagos Archipelago, Peros Banhos: Diamond Islet	5 15 00	71 43 47	......	......	......	.....
	Diego Garcia: N. end of Middle I	7 13 37	72 23 50	1 30	7 43	5.8	1.7
	Cargados Carajos: Establishment I., flagstaff	16 25 12	59 46 40	1 50	8 03	4.0	1.2
	Rodriguez Island: Mathurina Bay, Point Venus	19 40 22	63 25 38	0 20	6 32	5.5	1.6
Mauritius I.	Flat Island: Lighthouse	19 52 36	57 39 14	......	......	......	.....
	Cannonier Point: Lighthouse	19 59 45	57 32 35	......	......	......	.....
	Port Louis: Martello tower, Ft. George	20 08 46	57 29 26	0 48	7 00	1.6	0.3
	Royal Alfred Obsy	20 05 39	57 33 09	......	......	......	.....
	Grand Port: Fouquet I. light	20 24 20	57 47 14	......	......	......	.....

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

ISLANDS OF THE INDIAN OCEAN—Continued.

Coast.	Place.	Lat. S.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
	Réunion Island: St. Denis light	20 51 38	55 26 59	......	......	......	....
	Bel-Air light	20 53 11	55 36 18	......	......	......	....
	St. Paul light	20 59 45	55 16 18	......	......	......	....
	St. Pierre light	21 19 47	55 28 58	11 50	5 38	3.5	0.6
	Tromelin Island: N. end	15 51 37	54 28 46	......	......	......	....
	Agalegas Island: NW. pt	10 21 30	56 32 00	......	......	......	....
	Farquhar Islands: Hall's house	10 06 45	51 10 21	......	......	......	....
	Alphonse Island: SE. part (Trees)	7 00 30	52 44 57	......	......	......	....
	Coetivy Island: N. end	7 06 00	56 22 00	......	......	......	....
Madaga	Cape St. Mary: S. extreme	25 39 10	45 06 50	......	......	......	....
	Leven Island: Center	25 12 30	44 17 57	......	......	......	....
	Port Machikora: Barracouta I	25 03 00	44 07 20	......	......	......	....
	St. Augustine Bay: Nosi Vei I	23 38 25	43 38 20	5 40	11 52	9.8	2.9
	Murderers Bay: Center of Murder I	22 05 18	43 15 20	......	......	......	....
	Cape St. Vincent: Extreme	21 54 24	43 20 21	......	......	......	....
	Mourondava: Village	20 18 18	44 19 21	......	......	......	....
	Tsmano: Village	19 49 30	44 31 30	......	......	......	....
	Kovra Rythi Point: Extreme	17 53 00	44 02 20	......	......	......	....
	Coffin Island: Nosi Vao	17 29 00	43 45 18	......	......	......	....
	Cape St. Andrew: Extreme	16 12 10	44 29 05	......	......	......	....
	Boyanna Bay: Barabata Pt	16 07 00	45 17 09	......	......	......	....
	Cape Tauzon: Extreme	15 46 30	45 43 09	......	......	......	....
	Majunga (Mojanga): Lighthouse	15 43 45	46 18 45	4 15	11 28	10.9	3.2
	Majamba Bay: W. pt	15 11 42	46 57 29	......	......	......	....
	Narendri Bay: Moormora Pt	14 40 18	47 24 36	......	......	......	....
	Port Radama: Pt. Blair	13 59 00	47 58 21	......	......	......	....
	Radama Islands: N. pt. Nossuvee I	13 55 40	47 48 05	......	......	......	....
	Baratoube Bay: Ambubuka Pt	13 27 15	47 59 30	......	......	......	....
	Nosi Bé: Hellville Jetty	13 23 38	48 17 34	......	......	......	....
	Minow Islands: N. pt. Great I	12 49 30	48 38 57	......	......	......	....
	Cape San Sebastian: Extreme	12 27 20	48 45 45	......	......	......	....
	Port Liverpool: N. pt. of entrance	12 03 18	49 11 21	......	......	......	....
	Cape Amber: NE. extreme	11 57 30	49 17 25	......	......	......	....
	Port Lady Frances: Sunson Pt	12 23 20	49 35 56	......	......	......	....
	Port Looké: Pt. Bathurst	12 44 02	49 45 06	......	......	......	....
	Port Leven: S. pt. Nosi Hau I	12 49 00	49 54 00	......	......	......	....
	Andrava Bay: Berry Head	12 56 48	49 56 25	......	......	......	....
	Vohemar: Flagstaff	13 21 15	50 01 59	......	......	......	....
	Cape East: Ugoncy I	15 15 48	50 31 21	......	......	......	....
	Venangue Bé Bay: Entrance	15 54 50	50 16 05	......	......	......	....
	Port Choiseul: Maran Seelzy Village	15 27 55	49 49 11	3 45	9 57	5.1	1.5
	Cape Bellone: Extreme	16 14 00	49 50 59	......	......	......	....
	St. Marys Island: Light on Madame I	17 00 05	49 50 59	......	......	......	....
	Port Tantang: Flagstaff	16 42 30	49 56 15	......	......	......	....
	Fenerive Point: Flagstaff	17 23 16	49 32 04	......	......	......	....
	Tamatave: Pt. Hastie	18 09 47	49 25 31	4 00	10 12	7.3	2.1
	Mahanuru: Town	19 55 00	48 52 10	......	......	......	....
	Matatane: Village	21 58 10	48 14 50	......	......	......	....
	Santa Lucia: N. end of town, Obs. Rock	24 46 25	47 10 34	......	......	......	....
	Point Ytapere: Extreme	24 59 42	47 07 20	......	......	......	....
	Ytapere Bay: N. pt	24 58 50	47 04 24	......	......	......	....
	Fort Dauphin: Flagstaff	25 01 30	46 59 11	4 15	10 27	4.7	1.3
	Europa Island: Center	22 22 30	40 24 10	......	......	......	....
	Bassas da India: E. pt	21 29 00	39 40 39	......	......	......	....
	Geyser Reef: SE. extreme	12 26 30	46 32 35	......	......	......	....
	Mayotta Island: Zaoudzi	12 47 02	45 16 27	4 00	10 13	11.9	2.0
	Johanna Island: Landing place, Pomoni Harbor	12 16 20	44 24 54	......	......	......	....
	Mohilla Island: Numa Choa Harbor	12 25 00	43 47 00	......	......	......	....
	Glorioso Islands: W. islet	11 34 48	47 24 09	......	......	......	....
	Comoro Island: Islet in Mauroni Bay	11 40 44	43 19 15	4 45	10 58	10.0	1.7
	Assumption Island: Hummock	9 46 20	46 31 07	......	......	......	....

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

ISLANDS OF THE INDIAN OCEAN—Continued.

Coast.	Place.	Lat. S.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
	Aldabra Island: West I., E. side entrance	9 22 35	46 14 52				
	Cosmoledo Islands: Observation islet	9 41 20	47 32 25				
	Prince Edwards Islands: Marion I., Obs. spot, NE. side	46 49 30	37 49 15				
Crozet Is.	Penguin Islands Center of SW. islet	46 36 00	50 41 30				
	Possession Island: NW. pt	46 22 00	51 30 15				
	Twelve Islands: Summit NE. I	46 01 00	50 40 00				
	Navire Bay	46 28 18	51 50 00				
	Hog Island: Summit	46 10 40	50 35 00				
	East Island: Center	46 26 00	52 13 00				
Kerguelen Is.	Christmas Harbor	48 40 00	69 04 00				
	Blighs Cape	48 26 45	68 48 20				
	Cape Bourbon	49 42 00	68 54 00				
	Molloy, Port Royal Sound: U. S. Tr. of Venus Obs., 1874	49 21 22	70 04 31	0 14	6 36	4.6	1.3
	Cape Challenger	49 41 00	70 15 00				
	Balfour Rock	49 29 00	70 29 50				
	Heard Island: Cape Laurens, NW. end	53 02 45	73 15 30				
	Sealing station	53 13 00	73 52 00				
	McDonald Island, Summit	53 02 50	72 31 45				
	St. Pauls Island: Ninepin Rock	38 42 51	77 31 53	10 40	4 28	3.0	0.9
	Amsterdam Island: Summit, 2,750 feet	37 50 00	77 29 15	10 50	4 38	3.3	1.0
	Keeling or Cocos Islands: Direction I	12 06 22	96 53 02	5 20	11 32	5.1	1.5
	Christmas Island: Flying Fish Cove	10 25 19	105 45 57	7 10	1 00	4 5	1.3

SOUTH COAST OF ASIA.

Coast.	Place.	Lat. N.	Long. E.	H. W.	L. W.	Spg.	Neap.
Arabia.	Aden: Telegraph station	12 47 16	44 59 07	7 49	1 41	4.9	2.0
	Sughra: Sheik's house	13 22 00	45 40 50				
	Mokatein: Black ruin	13 24 50	46 26 35				
	Howaiyuh: Sheik's house	13 28 45	46 39 00				
	Banderburum: SE. house of town	14 20 10	48 56 45				
	Makalleh Bay: Flagstaff	14 31 15	49 07 35	8 20	2 07	6.8	2.8
	Shahah Roads: Customhouse	14 43 50	49 35 05				
	Sharmoh: Single house	14 49 00	49 57 05				
	Kosair: High house	14 54 40	50 16 35				
	Sihut: Center of town	15 12 00	51 10 30				
	Ras Fartak: Extreme pt	15 38 00	52 14 20				
	Damghot: Town	16 30 00	52 48 00				
	Merbat: Town	16 59 00	54 43 29	8 50	2 38	7.0	2.9
	Kuria Maria Is., Hullaniyeh I.: NE. bluff	17 32 45	56 03 05				
	Ras Sherbedat: Point	17 53 15	56 20 35				
	Cape Isolette: Islet	19 00 25	57 51 35				
	Masirah Island: Point Abu-Rasas	20 10 00	58 38 35				
	Point Ras Ye	20 31 30	58 58 35	9 45	3 32	9.6	4.4
	Ras-al-Hed: Extreme pt	22 32 40	59 48 35	9 15	3 03	8.9	4.1
	Maskat (Muscat): Maskat Pt	23 38 00	58 30 50	9 30	3 20	6.0	2.8
	Deimaniyeh Islands: E. islet	23 52 00	58 08 00				
	Sueik: Fort	23 51 30	57 26 00				
	Sohar: SE. tower of town hall	24 21 50	56 46 12				
	Khor Fakan Bay: W. end of village	25 21 00	56 22 56				
	Ras Musendom: N. end of island	26 24 13	56 32 22				
	Great Quoin Islet: Center	26 30 00	56 31 29				
	Sharjah: High tower with flagstaff	25 21 34	55 24 12				
	Abu-Thabi: Fort flagstaff	24 29 02	54 22 14				
	Al Beda'a Harbor: Nessah Pt., N. extreme	25 17 24	51 33 32				
	Ras Rakkin: NW. pt	26 10 55	51 13 46				
	Bahrein Harbor: Portuguese fort	26 13 56	50 31 18	5 15	11 30	6.4	3.7
	Basrah: Customhouse flagstaff	30 32 00	47 51 23				
	Kuweit Harbor: N. end of town	29 22 56	48 00 55	0 05	6 17	8.3	4.8

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

SOUTH COAST OF ASIA—Continued.

Coast.	Place.	Lat. N.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Persia.	Kàhrig Islet: Fort flagstaff	29 15 25	50 21 11				
	Abu Shahr: Residency flagstaff	28 59 07	50 50 35	7 12	1 13	2.6	1.5
	Shaikh Shu'aib Islet: E. end	26 47 40	53 23 36				
	Kais Islet: NE. pt	26 33 37	54 02 21	0 30	6 40	6.6	3.8
	Bàsidù: Chapel	26 39 12	55 16 47				
	Hanjam Islet: Ruined mosque	26 40 49	55 54 25				
	Kasm: Fort	26 57 27	56 17 37	10 50	4 35	11.6	5.3
	Jask Bay: Telegraph office	25 38 19	57 45 57	9 20	3 05	7.8	3.6
	Kub Kalat: High peak, 1,680 feet	25 29 45	59 40 32				
	Chahbar Bay: Telegraph office	25 16 43	60 37 40				
	Gwatar Bay: Islet	25 03 17	61 26 24				
Baluchistan.	Gwadar Bay: Telegraph office	25 07 19	62 19 42	9 20	3 05	8.1	3.7
	Pasni: Telegraph office	25 15 52	63 28 37				
	Ormarah: Telegraph office	25 11 55	64 37 02				
	Sunmiyani: Jam's house	25 25 19	66 35 39	8 50	2 35	8.1	3.8
	Cape Monze: Peak	24 50 03	66 39 58				
India.	Karachi: Manora light	24 47 37	66 58 06	10 15	4 00	7.3	3.4
	Observatory	24 49 50	67 01 33				
	Mandavi: Lighthouse	22 50 00	69 20 15				
	Beyt (Bet): Lighthouse	22 29 20	69 05 15	12 05	5 39	10.8	5.2
	Dwarka: Lighthouse	22 14 00	68 57 06				
	Temple spire	22 14 00	68 58 54				
	Porbandar: Lighthouse	21 38 00	69 36 00				
	Mangarol: Lighthouse	21 06 00	70 06 32				
	Diu Head: Lighthouse	20 41 20	70 50 45				
	Kutpur: Lighthouse	21 02 21	71 49 35				
	Bhaunagar: Lighthouse	21 47 00	72 14 00	4 27	11 18	29.8	15.1
	Perim Island: Lighthouse	21 35 54	72 21 08				
	Cambay: Flagstaff	22 17 00	72 35 10				
	Surat River: Tapti light	21 05 20	72 38 40				
	Surat: Minaret Adrusah	21 12 19	72 49 27				
	Bassein: Center of town	19 20 10	72 48 44				
	Bombay: Colaba Observatory	18 53 45	72 48 56	11 26	5 08	12.0	4.9
	Kenery Island light	18 42 08	72 48 49				
	Bankot: Fort Victoria	17 58 00	73 02 40				
	Ratnagherry: Fort	16 59 30	73 15 56				
	Viziadrug: Fort Flagstaff	16 33 26	73 19 39				
	Cape Ramas: W. bastion of fort	15 05 12	73 54 50				
	Goa: St. Denis Church	15 21 24	73 54 00				
	Aguada light	15 29 25	73 46 10	10 34	4 10	5.2	2.5
	Vingorla: Signal-station light	15 51 10	73 37 00				
	Vingorla Rocks: Lighthouse	15 53 20	73 27 15				
	Sedashigar Bay: Oyster Rock light	14 49 00	74 03 40	10 34	4 11	5.0	2.4
	Kumpta: Lighthouse	14 25 00	74 22 30				
	Hinàwar: Monument	14 17 28	74 26 40				
	Kundapur: Lighthouse	13 38 15	74 39 50				
	Mangalore: Lighthouse	12 52 17	74 50 40	10 50	4 28	6.5	3.4
	Kannanur: Lighthouse	11 51 10	75 21 51				
	Tellicherri: Flagstaff	11 45 00	75 29 40				
	Mahè: Lighthouse	11 42 00	75 31 10				
	Calicut: Lighthouse	11 15 10	75 46 40	11 21	4 59	2.7	1.4
	Cochin: Lighthouse	9 58 00	76 14 40	11 33	5 06	2.1	1.0
	Alipee: Lighthouse	9 30 00	76 20 40				
	Quilon: Tangacherri Point light	8 53 20	76 34 00	0 18	6 16	2.5	1.3
	Trivandrum: Observatory	8 30 47	76 56 45				
	Tiruchendore: Pagoda on pt	8. 29 55	78 07 47				
	Cape Comorin: Lighthouse	8 04 00	77 32 35				
	Tuticorin: Lighthouse	8 47 10	78 11 26	1 52	7 51	3.0	0.8
	Pamban Pass: Lighthouse	9 17 20	79 12 50	1 37	7 36	2.0	0.5

MARITIME POSITIONS AND TIDAL DATA.

SOUTH COAST OF ASIA—Continued.

Coast.	Place.	Lat. N.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Ceylon.	Manaar: Center of town	8 59 00	79 53 52				
	Colombo: Lighthouse	6 55 40	79 50 40	1 55	7 49	2.0	0.4
	Dondra Head: Lighthouse	5 55 30	80 34 12				
	Point de Galle: Lighthouse	6 01 25	80 13 04	2 02	8 07	1.9	0.4
	Great Bassas Rocks: Lighthouse	6 10 10	81 28 15				
	Little Bassas Rocks: Lighthouse	6 25 00	81 44 00				
	Batticaloa: Lighthouse	7 45 00	81 41 00				
	Trincomali: Dock-yard flagstaff	8 33 30	81 13 42	8 10	1 44	2.0	0.5
India.	Calimere Point: Lighthouse	10 18 00	79 51 30				
	Negapatam: Lighthouse	10 45 28	79 50 47	8 37	2 37	2.1	0.9
	Pondicherri: Lighthouse	11 55 40	79 50 10				
	Madras: Observatory	13 04 08	80 14 55				
	Lighthouse	13 05 15	80 17 27	8 41	2 26	3.1	1.2
	Pulicat: Lighthouse	13 25 15	80 19 12				
	Armeghon: Lighthouse	13 53 08	80 12 30				
	Kistna: Lighthouse	15 47 00	80 59 00				
	Masulipatam: Flagstaff	16 09 45	81 11 00				
	Coconada: Lighthouse	16 56 21	82 15 05	8 42	2 35	4.5	1.9
	Vizagapatam: Fort flagstaff	17 41 34	83 17 42	8 48	2 34	4.4	1.8
	Kalingapatam: Lighthouse	18 19 00	84 07 30				
	Gopalpur: Lighthouse	19 13 00	84 52 06				
	Gaujam: Fort	19 22 30	85 03 29				
	Juggernath: Great temple	19 48 17	85 49 09				
	False Point: Lighthouse	20 20 20	86 44 00	9 21	3 00	6.8	2.6
	Balasor River: Chandipur light	21 27 15	87 02 20				
	Saugor Island: Lighthouse	21 38 40	88 02 00				
	Diamond Harbor: Flagstaff	22 11 10	88 11 07				
	Calcutta: Ft. William semaphore	22 33 25	88 20 12	1 25	9 06	11.2	4.4
Burma.	Chittagong River: Lighthouse	22 11 00	91 49 00	1 02	7 56	13.1	5.6
	Akyab: Oyster Reef light	20 05 00	92 39 00				
	Old temple	20 08 53	92 52 40	9 40	3 28	7.6	3.0
	Ramree Island: S. pt	18 51 00	93 56 30				
	Chedubah Island: NW. peak	18 50 30	93 31 00				
	Cape Negrais: Extreme	16 01 30	94 13 16				
	Bassein River: Alguada Reef light	15 42 14	94 12 00				
	Bassein: Port Dalhousie	16 01 30	94 23 00	3 05	9 55	18.7	7.8
	Andaman Is.: Table Id., Lighthouse	14 12 30	93 22 30				
	Port Cornwallis, Rock in entrance	13 18 40	92 57 10	9 50	3 37	8.6	2.9
	Port Blair, Lighthouse	11 40 40	92 45 15	9 40	3 27	6.3	2.1
	Little Andaman Island, SE. pt	10 27 00	92 31 10				
	Krishna Shoal: Light vessel	15 37 26	95 37 32				
	Rangoon River: Grove Pt. light	16 30 01	96 23 00				
	Rangoon: Great Dagon pagoda	16 46 00	96 07 30	4 26	11 15	16.9	7.0
	Moulmein: Docks	16 26 00	97 38 00	3 07	10 49	11.7	5.0
	Moulmein River: Amherst Pt. light	16 04 45	97 33 05	2 12	8 49	19.2	7.4
	Double Island: Lighthouse	15 52 00	97 35 00				
	Tavoy River: Lighthouse	13 36 40	98 13 00	10 50	4 20	15.6	5.9
	Mergui: Courthouse	12 26 15	98 35 59	10 40	4 10	18.0	6.9
	Tenasserim	12 06 00	99 03 00				
	St. Matthew Island: Hastings Harbor	10 05 05	98 10 15				
	Pak Chan River: Lighthouse	9 58 00	97 35 00				
Malaysia.	Tongka Harbor, Junkseylon Island: Lighthouse	7 50 00	98 25 30				
	Pulo Penang: Fort Cornwallis	5 24 45	100 21 44	11 50	5 40	8.8	3.8
	Dinding Channel: Hospital Rock	4 13 05	100 34 15				
	One Fathom Bank: Lighthouse	2 52 10	100 59 12	5 50	12 00	14.4	6.2

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

SOUTH COAST OF ASIA—Continued.

Coast.	Place.	Lat. N.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Malaysia.	Cape Rachado: Lighthouse	2 24 08	101 51 02	......	......	......	....
	Malakka: Stat. St. Pauls Hill	2 11 30	102 15 00	7 20	1 08	10.5	4.5
	Singapore Strait: Coney Island light	1 09 57	103 44 47	......	......	......	....
	Singapore: Cathedral tower	1 17 33	103 51 11	10 18	4 02	7.6	3.2
	Singapore Strait: Pedra Branca light	1 19 57	104 24 08	......	......	......	....
	Summit Bintang great hill, 1,253 feet	1 04 20	104 27 21	......	......	......	....
	Rhio Straits, Pulo Sauh: Lighthouse	1 03 13	104 10 30	......	......	......	....
	Terkolei: Lighthouse	0 57 10	104 19 52	......	......	......	....
	Little Garras: Lighthouse	0 44 30	104 21 19	9 40	3 14	7.1	3.1
	Rhio, Bintang Island: Residency flagstaff	0 55 50	104 25 43	......	......	......	....
	Pitong Island: Peak	0 36 52	104 04 42	......	......	......	....
	Abang Besar Island: N. pt	0 36 30	104 11 31	......	......	......	....
		Lat. S.					
	Linga Island: Flagstaff	0 12 34	104 36 14	6 00	12 13	11.5	4.9
	Singkep Island: Mountain summit	0 26 13	104 30 15	......	......	......	....
	Menali Island: N. pt	0 57 51	105 38 20	......	......	......	....
		Lat. N.					
	Nicobar Islands, Car Nicobar: N. pt	9 15 40	92 48 00	......	......	......	....
	Nicobar Islands, Nancowry Harbor: Naval Pt	8 02 10	93 29 42	9 05	2 52	8.3	2.8
	Great Nicobar: W. pt. Galathea Bay	6 46 20	93 49 20	......	......	......	....
Sumatra.	Acheen (Acheh) Head: Pulo Bras light	5 45 00	95 04 33	......	......	......	....
	N. extreme	5 34 40	95 19 00	10 00	3 44	5.2	2.3
	Diamond Point: Lighthouse	5 15 58	97 30 11	11 50	5 34	8.7	3.7
		Lat. S.					
	Point Baru or Datu: Extreme	0 00 32	103 47 58	......	......	......	....
	Point Bon or Djabon: Extreme	1 00 55	104 21 30	......	......	......	....
	Moeara-Kompehi: Fort	1 23 13	103 59 14	......	......	......	....
	Djambi: Flagstaff of fort	1 35 33	103 36 41	......	......	......	....
	Palembang: Residency flagstaff	2 59 26	104 45 34	......	......	......	....
	Lampong Bay: Telok Betong light	5 27 00	105 15 58	......	......	......	....
	Blimbing Bay	5 55 02	104 32 36	5 40	11 52	2.6	0.7
	Kroë: Village	5 11 24	103 55 42	......	......	......	....
	Engano Island: Barioe anchorage	5 18 50	102 07 28	......	......	......	....
	Bintœan: River mouth	4 48 35	103 20 18	......	......	......	....
	Mega Island: N. pt	3 59 25	101 00 58	......	......	......	....
	Benkulen: Lighthouse	3 47 22	102 14 50	5 50	12 03	4.0	1.1
	Bantal: Village	2 44 54	101 17 25	......	......	......	....
	Indrapura Point: Extreme	2 10 35	100 50 06	......	......	......	....
	Pisang: Lighthouse	0 59 56	100 19 28	......	......	......	....
	Padang: Lighthouse	0 57 53	100 20 19	5 35	11 48	5.5	1.4
	Siberoet Island: Sigeb Pt	0 53 58	98 53 58	......	......	......	....
	Katiagam: Village	0 07 41	99 45 20	......	......	......	....
	Batoe Islands: N. point of Simoe Islet	0 03 13	98 05 55	......	......	......	....
	Summit of Tello	0 02 56	98 16 43	......	......	......	....
		Lat. N.					
	Ayer Bangis: Fort flagstaff	0 11 41	99 22 09	5 29	11 42	2.8	0.7
	Natal: Fort flagstaff	0 33 11	99 06 33	......	......	......	....
	Nias Island: Lagoendi Bay	0 34 47	97 43 43	......	......	......	....
	Sitoli	1 17 36	97 36 46	......	......	......	....
	Lapan	1 24 16	97 12 28	......	......	......	....
	Siboga: Flagstaff	1 44 24	98 46 08	......	......	......	....
	Singkel: Post office	2 16 47	97 45 06	......	......	......	....
	Bangkaru Islands: Bay	2 02 32	97 06 53	......	......	......	....
	Simaloe Island: NW. pt	2 51 30	95 56 02	......	......	......	....
	Tampat Toewon: Flagstaff	3 14 59	97 10 13	......	......	......	....
	Analaboe	4 08 14	96 07 23	......	......	......	....
	Batoe Toetong: Landing place	4 38 21	95 34 29	......	......	......	....

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

EAST COAST OF ASIA.

Coast.	Place.	Lat. S.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Banka Strait.	Java Head: First Pt. light	6 44 30	105 11 48	5 30	11 42	2.5	0.7
	Sunda Strait: Krakatoa I. peak	6 08 46	105 26 58	6 50	0 37	3.8	1.1
	North Watcher Island: Lighthouse	5 12 17	106 27 33				
	Lucipara I.: Beacon	3 13 05	106 13 02				
	Banka Island: Tobol Ali Fort	3 00 48	106 27 22	[9 05]	[2 52]	[10.1]	
	Berikat, summit	2 34 18	106 50 36				
	Nanka I.: Lighthouse	2 23 20	105 44 30	[6 50]	[0 38]	[9.3]	
	Banka Island: Mintok light	2 04 03	105 09 45				
	Blinyu	1 38 26	105 46 28				
	Crassok Pt	1 29 00	106 57 30				
Gaspar Strait.	Shoalwater Island: Lighthouse	3 19 10	107 12 42	[2 08]	[8 21]	[5.6]	
	Pulo Lepar: Lighthouse	2 56 52	106 54 38				
	Pulo Jelaka: Lighthouse	2 52 05	107 00 43				
	Billiton Island: Tanjong Pandan flagstaff	2 44 40	107 38 46				
	Langkuas I. light	2 32 12	107 37 15	[3 17]	[9 29]	[6.6]	
	Gaspar Island: Peak	2 24 30	107 03 33				
Entrance to China Sea.	Carimata Island: Sharp peak	1 33 24	108 55 13				
	Pulo Eu: Center	2 07 00	104 17 00				
	Pulo Aor: S. peak, 1,805 feet	2 26 30	104 34 06				
		Lat. N.					
	St. Barbe Island: Center of W. side	0 07 26	107 13 00				
	Direction Island: S. pt	0 14 19	108 01 47				
	Dato Island: Summit	0 06 37	108 37 05				
	St. Julian Island: Summit	0 55 00	106 45 00				
	Tambelan Island: S. pt	0 56 52	107 32 57				
	Tamban I. obs. station	1 00 27	106 24 10				
	Victory Island: S. pt	1 34 41	106 18 27				
	Anamba Islands: White rock	2 18 10	105 35 58				
	Pulo Repon	2 25 00	105 52 00				
	Pulo Domar	2 44 31	105 22 57				
	St. Pierre Rock: S. pt	1 51 42	108 38 55				
	Natuna Islands: Pyramidal rocks	4 03 00	107 21 40				
	Semione I	4 31 00	107 42 30				
Java.		Lat. S.					
	Anjer: Fourth Pt. light	6 04 15	105 53 05	7 11	0 58	2.4	0.7
	Bantam: Flagstaff	6 01 20	106 08 20				
	Batavia: Observatory	6 07 40	106 48 37	[11 58]	[5 46]	[3.0]	
	Buitenzorg: Palace tower	6 35 45	106 49 11				
	Boompjeo Island: Racket I. light	5 56 15	108 22 37				
	Cheribon: Lighthouse	6 43 00	108 34 00				
	Tegal: Flagstaff	6 51 09	109 08 07				
	Pekalongan: Light W. of entrance	6 51 29	109 41 08				
	Samarang: Lighthouse	6 57 09	110 25 03	[6 00]	[12 13]	[4.0]	
	Rembang: Residency flagstaff	6 42 18	111 20 32				
	Surabaya: Time-ball station	7 12 10	112 43 58	12 07	5 54	4.9	1.7
	Pasuruan: Lighthouse	7 37 30	112 55 00	11 44	5 31	6.2	2.3
	Madura Island: Lighthouse	7 02 00	112 41 09				
	Soemenep flagstaff	7 02 30	113 53 45				
	Besuki: Lighthouse	7 43 25	113 41 10				
	Cape Sedano: NE. pt. of Java	7 49 00	114 26 53				
	Banjuwangi: Fort	8 12 30	114 22 55	10 00	3 45	7.8	2.6
	Bantenan: S. pt. of Java	8 47 00	114 25 13				
	Barung Island: S. pt	8 32 00	113 15 00				
	Kambangan Island: Lighthouse	7 46 30	109 02 12	8 33	2 21	5.2	1.8
	Cape Anjoe: Extreme	7 25 00	106 24 30				

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

EAST COAST OF ASIA—Continued.

Coast.	Place.	Lat. S.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Smaller Dutch East Indian Islands.	Karimon Djawa Island: Flagstaff	5 52 57	110 25 29				
	Rawean Island: Sangkapura flagstaff	5 51 18	112 39 10				
	Great Solombo Island: NW. pt	5 32 28	114 23 42				
	Arentes Island: S. pt	5 05 46	114 35 00				
	Bali Island: Buleleng lighthouse	8 05 30	115 03 48				
	Peak, 11,326 ft	8 21 00	115 28 00				
	Badong Bay, Kotta village	8 42 30	115 08 47	10 50	4 38	8.7	3.0
	Lombok Island: Peak, 12,379 ft	8 23 00	116 27 30				
	Ampenam light	8 34 15	116 04 09	7 50	1 37	5.8	2.0
	Sumbawa I.: Sumbawa village	8 32 00	117 20 33				
	Tambora Volcano, summit E. side of crater	8 12 30	117 57 00				
	Bima, flagstaff	8 27 00	118 43 55	0 00	6 12	5.7	2.0
	Postilion Islands: N. island	6 31 00	118 43 00				
	Maria Reigersbergen I.	7 30 00	117 56 00				
	Ardassier Islands: S. id	7 35 00	117 22 00				
	Brill Reef: Lighthouse	6 05 50	118 56 50				
	Hegadis Island	6 07 00	122 40 00				
	Token Bessi I.: Wangi-Wingi, NW. pt	5 15 00	123 32 00				
	Binongko, S. pt	6 17 00	123 59 00				
	Gunong Api: Volcano	6 43 00	126 43 30				
	Lucipari Islands: N. islet	5 28 30	127 30 00				
	Flores Island: Reo village	8 16 15	120 29 55				
	Ende village	8 50 55	121 38 40				
	Flores Head, extreme	8 04 45	122 52 00				
	Komba Island: Peak, S. part	7 48 00	123 31 00				
	Adenara Island: Summit, Mount Woka	8 20 30	123 15 00				
	Lombata Island: Mount Lamararap	8 33 00	123 22 00				
	Pantar Island: S. peak of saddle on S. pt.	8 34 00	124 06 00				
	Ornbay Island: Dololo anchorage	8 12 00	124 23 00				
	Timor Island: Deli, customhouse	8 34 00	125 33 57	0 45	6 58	5.7	2.0
	Atapopa	9 00 00	124 52 00				
	Koupang, Fort Concordia	10 09 54	123 33 57	10 50	4 37	8.5	2.9
	Rotti Island: W. pt	10 46 00	122 52 00				
	Saru Island: Seba Bay, on NW. side	10 29 00	121 46 00				
	Sandalwood Island: Nangamessie	9 35 03	120 14 30	11 20	5 07	16.5	5.6
Molukka Islands.	Wetta Island: Ilwaki road	7 53 00	126 22 00				
	Roma Island: W. pt	7 38 00	127 19 00				
	Moa Island: Buffalo Peak, 4,100 ft	8 12 00	128 01 00				
	Sermata Island: NE. pt	8 14 00	129 00 00				
	Damma Island: Kulewatta Harbor, N. pt.	7 03 00	128 28 00				
	Nila Island: Center	6 44 00	129 29 00				
	Mano or Bird Island: NW. extremity	5 32 50	130 17 44				
	Timor Laut Island: Olilet, on E. coast	7 55 00	131 23 30				
	Vordate Island: S. pt	7 04 00	131 55 00				
	Mulu Island: N. pt	6 35 00	131 34 00				
	Aru Islands: S. island	7 05 00	134 31 00				
	N. pt	5 20 00	134 40 00				
	Great Ki Island: S. pt	5 56 00	132 54 00				
	Tello Islands: S. island, summit	5 20 00	131 58 00				
	Tehor Island: NE. pt	4 44 00	131 47 00				
	Matabella Islands: Kukur	4 33 00	131 50 00				
	Goram Islands: Goram Mosque	4 03 05	131 25 23				
	Banda Island: Mole	4 31 53	129 53 18	1 45	7 57	9.0	6.6
	Bouro Island, Kajeli: Fort Defense	3 22 48	127 06 18	1 20	7 32	4.2	3.1
	Ceram Island: Kawa	2 55 52	128 07 04				
	Amboina Island: Lighthouse	3 41 00	128 10 00	2 20	8 32	7.5	5.5
	Sula Islands, Taliabo Island: NW. pt	1 44 00	122 20 00				
	Mangola Island: E. pt	1 48 12	126 21 19				
	Besi Island: E. pt	2 28 00	126 01 00				
	Obi Major Island: W. pt	1 30 00	127 18 00				
	Popa Island: Outer Extremity Bay	1 11 21	129 55 48				
	Mysole Island: Efbe Harbor	2 04 00	130 12 00				

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

EAST COAST OF ASIA—Continued.

Coast.	Place.	Lat. S.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Molukka Islands.	Gebey Island: NW. pt.	0 02 02	129 17 30	......	......	......	......
	Halmahera I., Cape Tabo: E. extreme	0 11 00	128 52 00	......	......	......	......
	(Gillolo I.) Cape Salawag: N. E. pt.	1 26 00	128 37 00	......	......	......	......
	Derrick Point: N. extreme	2 12 00	128 03 30	......	......	......	......
	Makkian or Makjan I.: Fort Reeburgh	0 24 00	127 21 00	......	......	......	......
	Ternate Island: Residency flagstaff	0 47 13	127 22 39	5 00	11 10	3.9	2.9
		Lat. S.					
	Batian Island: Church	0 38 03	127 28 21	......	......	......	......
Borneo.		Lat. N.					
	Tanjong Datu	2 05 15	109 39 07	......	......	......	......
	Saráwak River: Po Pt. light	1 43 50	110 30 30	4 00	10 12	9.0	3.9
	Saráwak: Fort	1 33 55	109 20 40	5 20	11 35	14.1	6.1
	Cape Sirik: Lighthouse	2 45 20	111 21 20	......	......	......	......
	Tanjong Barram	2 36 15	113 58 57	......	......	......	......
	Bruni River: Lighthouse	5 02 00	115 03 00	......	......	......	......
	Labuan I., Victoria Hbr.: Lighthouse	5 15 25	115 16 05	9 35	3 23	5.5	2.4
	Sandakan Harbor: Flagstaff	5 50 24	118 07 12	12 00	5 50	6.8	1 to 4
	Unsang: Anchorage	5 16 30	119 16 00	......	......	......	......
	Tanjong Mangkalihat E. pt. of Borneo	1 01 12	119 00 00	......	......	......	......
		Lat. S.					
	Pamaroong I.: E. pt. delta River Koetei	0 45 00	117 37 00	[7 45]	[1 33]	[7.0]	......
	Pulo Laut: S. pt. Koengit Islet	4 05 42	116 01 40	......	......	......	......
	Selatan Point: Extreme of Sita Pt	4 10 40	114 42 18	......	......	......	......
	Bandjermasin: Residency flagstaff	3 18 55	114 34 56	......	......	......	......
	Sampit Bay: Bandaran Pt	3 16 00	113 08 00	......	......	......	......
	Kottaringin Bay: Samadra I	2 54 00	111 24 00	......	......	......	......
	Succadana: Town	1 14 00	109 58 00	......	......	......	......
	Padang Tikar: Point	0 40 00	109 16 00	7 00	0 47	7.2	3.1
Celebes Island.	Port Laykan: SW. pt. of Celebes	5 36 00	119 26 00	......	......	......	......
	Makassar: Fort light	5 08 09	119 23 55	4 40	10 55	3.9	2.9
	Palos Bay: Village at head	0 57 00	119 47 30	......	......	......	......
		Lat. N.					
	Cape Rivers: NE. Cape, Slime Islet	1 20 00	120 43 30	......	......	......	......
	Gorontalo: Lighthouse	0 29 41	123 03 08	......	......	......	......
	Manado Bay: Lighthouse	1 31 00	124 50 00	6 00	12 15	4.3	3.1
	Bajuren Island: Summit	2 07 00	125 22 00	......	......	......	......
	Tagulanda Island: Peak	2 22 00	125 24 30	......	......	......	......
	Seao Island: Conical peak	2 44 00	125 26 00	......	......	......	......
	Sauguir Island: S. pt. Cape Palumbatu	3 21 00	125 39 00	......	......	......	......
	Taluat Island: Kabruang I., SE. pt	3 49 00	127 02 30	......	......	......	......
	Cape Flesko: Extreme	0 27 00	124 26 00	......	......	......	......
		Lat. S.					
	Cape Talabo: E. end	0 46 00	123 27 00	......	......	......	......
	Wowoni Island: N. pt	3 58 00	123 00 00	......	......	......	......
	Bouton Island: N. pt	4 23 30	123 04 00	......	......	......	......
	E. pt	5 15 00	123 16 00	......	......	......	......
	Fort	5 29 15	122 36 41	......	......	......	......
	Cape Lassa: Extreme	5 35 00	120 29 00	......	......	......	......
	Salayar Island: N. pt	5 47 00	120 30 00	......	......	......	......
	S. pt	6 26 00	120 28 30	......	......	......	......
Philippine Is.		Lat. N.					
	Balabac Island, Cape Melville: Lighthouse	7 49 25	117 00 00	......	......	......	......
	Palawan Island, Cape Bulilujan: S. extreme	8 20 25	117 09 35	......	......	......	......
	Victoria Peak, 5,680 ft.	9 22 30	118 17 30	......	......	......	......
	Port Royalist: Tide Pole Pt. Light	9 43 43	118 43 03	[11 30]	[5 20]	[6.5]	......
	Taytay Fort	10 50 00	119 31 10	......	......	......	......

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

EAST COAST OF ASIA—Continued.

Coast.	Place.	Lat. N.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Philippine Islands.	Palawan Island, Port Barton: Bubon Pt.	10 29 19	119 05 36	......	......	......	.....
	Kabuli I.: Summit, N. extreme	11 26 25	119 29 55	......	......	......	.....
	Cuyo Island: Obs. spot	10 51 26	121 00 25	......	......	......	.....
	Agutaya Islet: Summit of Mt. Aguade	11 09 09	120 56 26	......	......	......	.....
	Quiniluban Islet: Summit	11 25 47	120 45 38	......	......	......	.....
	Culion Island: Fort	11 53 53	120 00 48	......	......	......	.....
	Busuanga Island: Mt. Tundalara	12 02 09	120 12 56	......	......	......	.....
	Apo Islet: Summit	12 39 46	120 27 18	......	......	......	.....
	Caluya Island: Summit	11 54 28	121 30 24	......	......	......	.....
	Semerara Island: N. extremity	12 06 45	121 20 10	......	......	......	.....
	Mindoro Island: Mangarin Pt., SE. extremity	12 20 03	121 03 33	......	......	......	.....
	Sablayan Pt., Vantay	12 50 15	120 44 42	......	......	......	.....
	Monte Calavite	13 28 40	120 22 33	......	......	......	.....
	Escarceo Pt	13 31 35	120 59 17	......	......	......	.....
	Pt. Dumaly	13 06 05	121 29 20	......	......	......	.....
	Ylin Island	12 17 15	121 01 53	......	......	......	.....
	Lubang Island, Port Tulig	13 49 30	120 09 58	......	......	......	.....
	Luzon Island, Batangas: Ast. station	13 45 22	121 02 56	......	......	......	.....
	Balayan: Plaza Rizal	13 56 17	120 43 37	[11 07]	[4 50]	[4. 9]	.....
	Loro Peak: Summit, 3,985 feet	14 12 20	120 38 10	......	......	......	.....
	Caballo I.: Lighthouse	14 21 48	120 36 40	......	......	......	.....
	Corregidor Island: Lighthouse	14 22 27	120 33 48	[10 22]	[3 56]	[4. 4]	.....
	Cavite: Sangley Pt. light	14 29 57	120 54 43	......	......	......	.....
	Manila: Pasig lighthouse	14 35 49	120 57 19	10 44	[4 10]	[4. 6]	.....
	Manila: Cathedral	14 35 31	120 58 06	......	......	......	.....
	Subic: Town	14 52 36	120 13 52	[9 42]	[4 33]	[3. 8]	.....
	Capones Islet: Lighthouse	14 55 33	120 00 15	......	......	......	.....
	Iba: Ast. station	15 19 30	119 57 11	......	......	......	.....
	Port Masinloc: Bani Pt	15 34 48	119 54 16	......	......	......	.....
	Santa Cruz: Plaza	15 45 43	119 54 00	......	......	......	.....
	Sual: Army Hospital	16 04 06	120 06 01	[10 20]	[3 33]	[2. 4]	.....
	Silaqui Islet: Summit	16 27 15	119 56 10	[10 21]	[3 44]	[2. 3]	.....
	Port San Fernando: Main street	16 37 15	120 18 25	[9 40]	[3 29]	[2. 6]	.....
	Candon: Ast. station	17 11 43	120 26 14	......	......	......	.....
	Port Santiago: Remarkable tree S. of port	17 16 55	120 25 07	......	......	......	.....
	Vigan: Race track	17 33 56	120 22 51	......	......	......	.....
	Salomague Island: Port Salomague flagstaff	17 47 17	120 25 04	......	......	......	.....
	Currimao: Town	18 01 09	120 28 44	......	......	......	.....
	Cape Bojeador: Lighthouse	18 31 08	120 35 35	......	......	......	.....
	Mairaira Pt.: Semaphore	18 39 02	120 50 53	......	......	......	.....
	Aparri: Plaza	18 21 43	121 37 27	5 43	−0 02	3. 2	1.9
	Port San Vicente: San Vicente Islet	18 28 32	122 04 14	......	......	......	.....
	Cape Engaño: Roña Islet	18 32 02	122 05 49	......	......	......	.....
	Camiguin I.: Summit	18 50 26	121 48 26	6 00	−0 12	5. 0	2. 7
	Fuga Island: W. summit	18 52 54	121 15 42	......	......	......	.....
	Dalupiri Island: Peak	19 03 03	121 11 28	......	......	......	.....
	Calayan Island: NE. pt	19 22 00	121 32 00	......	......	......	.....
	Babayan Claro Island: W. pt	19 30 00	121 52 00	......	......	......	.....
	Balingtang Islands	19 58 30	122 14 00	......	......	......	.....
	Batan Island: Mount Irada	20 28 30	122 01 20	......	......	......	.....
	Ibayat Island: Mount Santa Rosa	20 48 00	121 52 30	......	......	......	.....
	Yami Island: Islet off SW. part	21 04 56	121 58 24	......	......	......	.....
	Luzon Island, Port Dimasalasan: Entrance	17 20 17	122 19 20	......	......	......	.....

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

EAST COAST OF ASIA—Continued.

Coast.	Place.	Lat. N.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Philippine Islands.	**Luzon Island,** Polillo I: Port Polillo	14 51 00	121 54 48	......	......	......	.....
	Tabaco: Church belfry	13 21 33	123 43 53	6 08	0 00	5.2	2.8
	Catanduanes Islands: N. islet	14 09 00	124 06 48	......	......	......	.....
	Catanduanes Islands: S. extreme	13 28 30	124 04 48	......	......	......	.....
	Point Calaan: S. extreme	12 31 20	124 04 18	......	......	......	.....
	Port Sorsogon, Tinacos Islet	12 52 20	123 49 22	......	......	......	.....
	Masbate Island, Palanog: Pier	12 22 10	123 35 58	......	......	......	.....
	Bugui Pt. lighthouse	12 36 00	123 14 36	......	......	......	.....
	Camasusu I.: Summit	12 10 03	123 12 47	......	......	......	.....
	Tintolo Point: Extreme	11 56 09	123 07 34	......	......	......	.....
	Burias Island: Busainga	13 07 40	123 02 45	[4 30]	[10 20]	[5.5]	.....
	Marinduque I.: Summit of Mount Catala	13 18 10	121 54 33	......	......	......	.....
	Maestro de Campo Island, Port Concepcion: Point Fernandez	12 54 03	121 43 08	......	......	......	.....
	Banton Island: Banton Mountain	12 56 56	122 04 48	......	......	......	.....
	Tablas Island: Tablas Head	12 38 42	122 08 38	......	......	......	.....
	Sanguilan Pt	12 33 44	121 58 32	......	......	......	.....
	Carabao Island: W. pt	12 03 15	121 53 53	......	......	......	.....
	Romblon Island: Sabang Pt. light	12 36 00	122 17 08	......	......	......	.....
	Summit over port	12 35 33	122 16 26	......	......	......	.....
	Sibuyan Island: Summit	12 24 55	122 33 23	......	......	......	.....
	Samar Island, Guiuan: Pier	11 01 30	125 43 14	......	......	......	.....
	Catbalogan: Fort	11 46 44	124 51 37	......	......	......	.....
	Maripipi Island: Summit	11 47 30	124 18 15	......	......	......	.....
	Leyte, Tacloban	11 15 08	124 59 56	6 53	1 25	1.5	1.1
	Ormoc: Ast. station	11 00 17	124 36 20	......	......	......	.....
	Palompon: Church	11 02 37	124 22 07	......	......	......	.....
	Maasin	10 07 39	124 50 15	11 47	4 50	2.8	2.0
	Bohol I., Lapiniu I.: Mount Basiao	10 03 22	124 32 35	......	......	......	.....
	Cebu Island, Cebu: Plaza	10 17 30	123 54 18	......	......	......	.....
	Siquijor Island, Port Canoan: S. pt. of entrance	9 15 17	123 34 26	......	......	......	.....
	Negros Island, Port Bunbonon; E. pt. of entrance	9 03 37	123 06 09	......	......	......	.....
	Dumaguete: Town	9 18 25	123 18 43	......	......	......	.....
	Volcano of Malaspina, 8,192 ft	10 24 35	123 07 05	......	......	......	.....
	Bacalod: Town	10 40 21	122 55 42	......	......	......	.....
	Guimaras I., Inampulugan I., SW. pt	10 26 38	122 40 20	......	......	......	.....
	Panay Island, Iloilo: Fort	10 41 27	122 34 26	11 06	5 22	4.2	1.9
	San José	10 44 08	121 54 27	......	......	......	.....
	Pan de Azucar	11 16 47	122 09 09	......	......	......	.....
	Batbatan Island: Summit	11 28 20	121 52 36	......	......	......	.....
	Pucio Point: Extreme	11 45 30	121 58 59	......	......	......	.....
	Port Batan: Village	11 35 40	122 28 50	......	......	......	.....
	Capiz: Town	11 35 06	122 45 03	......	......	......	.....
	Siargao Island, Port Sapao: Semaphore	10 11 26	126 02 53	......	......	......	.....
	Gibdo Island: Semaphore	9 53 00	125 31 17	......	......	......	.....
	Bucas Island: E. pt. of Port Sibanga	9 41 34	125 58 22	......	......	......	.....
	Mindanao Island: Surigao	9 47 53	125 28 30	[11 40]	[6 15]	[6.5]	.....
	Cape St. Augustin	6 14 30	125 47 48	......	......	......	.....
	Davao: Mole	7 01 22	125 34 35	6 00	−0 13	6.9	5.1
	Saranguni Islets: W. islet	5 22 30	125 13 48	......	......	......	.....
	Basianang Bay: N. pt. of Donauang I	6 28 50	123 57 37	......	......	......	.....
	Polloc: Small hill back of town	7 21 15	124 11 42	......	......	......	.....
	Santa Cruz Islands: SE. islet	6 52 15	122 04 00	......	......	......	.....
	Zamboanga: Fort	6 54 03	122 04 52	6 50	0 42	3.8	2.8

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

EAST COAST OF ASIA—Continued.

Coast.	Place.	Lat. N.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Philippine Islands.	Mindanao Islands Sibuco Bay: Hill S. of beach	7 18 05	122 03 18				
	Port Sta. Maria: Fort.	7 45 41	122 04 58				
	Dapitan: Village	8 40 15	123 23 13	[10 48]	[4 50]	[5. 1]	
	Misamis: Fort	8 08 29	123 50 44				
	Camiguin Island: Mount Camiguin	9 10 19	124 42 50				
	Sombrero Rock: Center	10 43 00	121 33 00				
	Piedra Blanca: Center	10 27 00	121 03 00				
	Cagayanes Islands: Rocky islet between two larger islands	9 35 30	121 23 30				
	San Miguel Isles: E. pt. of Manuk Manukan.	7 43 00	118 27 00				
	Cagayan Jolo Island: Middle of W. coast.	7 00 38	118 26 06				
	Omapui Island: NW. extreme	4 54 10	119 22 45				
	Sibutu Island: Hill on E. coast	4 49 30	119 48 00				
	Simonor Island: NW. pt	4 55 30	119 46 45				
	Bahaltolis Island: Sandakan Harbor	5 50 00	118 11 00				
	Bongao Island: S. pt	5 00 30	119 44 15				
	Keenapoussan Island: Center	5 13 00	120 40 45				
	Bubuan Island: Lagoon entrance	5 25 15	120 35 00				
	Cuad Basang Island: SW. pt	5 27 10	120 11 30				
	Siassi: Town, center of old fort	5 32 35	120 48 51	5 54	−0 18	8. 6	6. 4
	Bulipongpong Island: Center hill	5 41 30	120 49 45				
	Tapul Island: Center hill, 1,676 ft	5 44 30	120 55 00				
	Jolo Islands: Maimbun Anchorage, dry bank	5 54 45	121 00 40				
	Dalrymple Harbor, Tulyan Islet	6 02 30	121 18 20				
	Jolo lighthouse	6 03 30	120 59 52	[9 38]	[3 10]	[5. 0]	
	Doc Can Islet: W. extreme	5 52 30	119 55 55				
	Pangituran Island: SW. pt	6 15 15	120 29 30				
	Basilan Island: La Isabela	6 42 43	121 56 50				
Gulf of Siam.	Pulo Varella: Center	3 17 00	103 40 00				
	Pulo Brala: Center	4 53 00	103 38 00				
	Tringano River: N. pt	5 21 40	103 08 00	8 00	1 48	5. 8	2. 5
	Great Redang Harbor: Bukit Mara	5 44 21	103 01 45				
	Kelantan R.: Lighthouse	6 13 25	102 10 30				
	Tanjong Patani: NE. pt	6 57 01	101 17 39				
	Singora (Sungkla): SW. pt. of Koh Ngu	7 13 54	100 36 12	8 20	2 08	2. 8	1. 2
	Koh Krah Islet: SE. pt	8 24 47	100 45 27				
	Bangkok: Wat Cheng	13 44 32	100 29 29	8 00	2 00	7. 3	3. 1
	Cape Liant: Koh Chuen Lighthouse	12 31 00	100 57 30				
Cochin China.	Chentabun River: Entrance, Bar I	12 27 43	102 04 19	10 00	3 50	4. 5	2. 1
	Koh Chang: Obsy. I. on W. side	12 01 55	102 15 47				
	Koh Kong R.: S. pt. of entrance	11 33 00	102 57 14				
	Kusrovie Rock: Center	11 06 25	102 47 49				
	Koh Tang Rocks: Veer Islet	10 13 45	102 52 45				
	Panjang Island: West Pt	9 18 14	103 27 14				
	Obi Islands: Lighthouse	8 25 20	104 48 30				
	Saigon: Observatory	10 46 47	106 42 12	5 00	11 20	9. 8	4. 2
	Mitho: S. gate of citadel	10 21 16	106 20 38				
	Cape St. James: Lighthouse	10 19 51	107 04 55				
	Cape Padaran: Extreme	11 21 00	108 58 00				
	Cape Varella: Extreme	12 53 40	109 23 42				
	Quin Hon: Battery flagstaff	13 45 23	109 14 52				
	Canton Pulo: Lighthouse	15 23 34	109 05 35				
	Cham-Callao Islet: Watering place	15 57 10	108 32 47				
	Tourane Bay: Lighthouse	16 07 00	108 11 30				
	Hon-Mé: Summit	19 22 14	105 55 22				
	Nam-Dinh: Citadel tower	20 25 30	106 08 41				
	Hon Dau Island: Lighthouse	20 40 03	106 47 10	9 00	2 48	4. 3	2. 1
	Haifong: Observation pagoda	20 51 44	106 40 54				
	Haiduong: Citadel tower	20 56 29	106 17 56				
	Hanoi: Citadel tower	21 01 57	105 48 40				

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

EAST COAST OF ASIA—Continued.

Coast.	Place.	Lat. N.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
China Sea.	Condore Islands: Lighthouse	8 40 06	106 41 42				
	Safatu Island: Summit	9 58 23	109 06 00				
	Ceicer de Mer Island: SW. hill	10 32 36	108 56 27				
	Natuna Islands: Murundum I., SE. pt	2 02 55	109 06 10				
	Low I.	3 00 00	107 48 00				
China.	Pakhoi: Customhouse flagstaff	21 29 00	109 06 00	5 00	11 12	14.0	6.6
	Hainan Island: Cape Bastion, extreme	18 09 00	109 35 00				
	Gaalong Bay, E. Brother.	18 11 30	109 41 30				
	Lighthouse	20 01 15	110 16 10				
	Paracel Islands: Triton I	15 46 30	111 14 30				
	Observation bank	16 36 00	111 40 30				
	Lincoln I	16 40 07	112 43 32				
	Woody I	16 49 55	112 20 44				
	Pratas Island: NE. part	20 42 03	116 43 07				
	Ty-fung-kyoh Island: Center	21 22 30	111 10 30				
	Tien-pak Harbor: Pauk Pyah Islet	21 24 15	111 15 25	11 50	5 37	8.2	3.8
	Song-yui Point: Extreme	21 31 00	111 38 30				
	Hui-lang-san Harbor: Mamechow Islet	21 34 00	111 46 43				
	Mandarins Cap: Summet, 200 ft	21 28 00	112 21 30				
	Macao: Fort Guia light	22 11 40	113 34 00	9 50	3 38	6.3	3.0
	Fort San Francisco	22 11 24	113 33 25				
	Canton: Dutch Folly light	23 06 35	113 16 30	2 00	8 00	5.1	2.4
	Raleigh Rock: Center	22 02 00	113 47 00				
	Gap Rock: Lighthouse	21 48 50	113 56 20				
	Hongkong: Cathedral	22 16 52	114 09 31				
	Wellington Battery	22 16 23	114 10 02	9 20	2 52	4.4	2.0
	Lema Island: Lema Head	22 03 40	114 19 25				
	Nine-pin Rock: Center	22 15 45	114 22 07				
	Tuni-ang Island: Summit	22 27 06	114 36 45				
	Single Island: E. summit	22 24 06	114 39 12				
	Mendoza Island: Summit	22 30 42	114 50 00				
	Pank Piah Rock: Summit	22 32 54	115 01 00				
	Pedra Blanca Rock: Summit, 130 ft	22 18 30	115 06 54				
	Chino Bay: Obs. spot	22 48 14	115 47 56				
	Cupchi Point: Hill	22 48 07	116 04 26				
	Breaker Point: Lighthouse	22 56 24	116 29 44				
	Cape of Good Hope: Lighthouse	23 14 00	116 47 00				
	Swatow: British consulate	23 20 43	116 40 22	2 50	9 00	7.5	3.5
	Lamock Island: Lighthouse	23 15 43	117 17 04				
	Brothers Islets: SE. Islet	23 32 30	117 42 00				
	Tong-sang Harbor: Fall Peak	23 47 15	117 36 48	11 20	5 08	12.0	7.6
	Chapel Island: Lighthouse	24 09 49	118 13 30				
	Amoy: Taitan I. light	24 23 16	118 10 00	0 05	6 13	15.5	9.9
	Dodd Island: Lighthouse	24 25 44	118 30 11				
	Chinchin Harbor: Pisai Islet	24 49 13	118 41 00				
	Pyramid Point: Extreme	24 52 12	118 58 00				
	Ockseu Island: Lighthouse	24 59 36	119 27 07				
	Sorrel Rock: Summit	25 02 18	119 10 36				
	Lamyit Island: High Cone Peak	25 12 00	119 35 00				
	Hungwha Channel: Sentry I	25 16 30	119 45 00				
	Turnabout Island: Lighthouse	25 26 10	119 56 07				
	East Dog Island: Lighthouse	25 58 10	119 59 02				
	Min River: Pagoda, Losing I	25 59 00	119 27 16	0 30	7 00	19.3	12.2
	Temple Pt	26 08 26	119 37 35	9 45	3 33	19.0	12.0
	Alligator Island: Summit	26 09 29	120 24 06				
	Tung-yung Islands: Peak, N. end	26 22 37	120 29 40				
	Coney Island: Summit	26 30 00	120 10 00				
	Double Peak Island: Highest peak	26 36 06	120 11 12				
	Pih-seang Island: Town I	26 42 30	120 22 42				
	Dangerous Rock: Summit	26 51 25	120 32 33				
	Tae Islands: Summit	26 58 52	120 42 34				
	Nam-quan Harbor: Bate I	27 09 20	120 25 50	9 50	3 38	17.2	10.9
	Ping-fong Island: Summit	27 09 42	120 32 42				

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

EAST COAST OF ASIA—Continued.

Coast.	Place.	Lat. N.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
China.	Pih-quan Peak: Summit	27 19 18	120 27 14				
	Port Namki: E. horn	27 26 18	121 06 36				
	Pih-ki-shan Island: Summit	27 37 36	121 12 09				
	Pe-shan Islands: Summit, SW. end	28 05 07	121 30 04				
	Tung-chuh Island: Summit	28 43 45	121 55 21				
	Kweshan Islands: Patahecock	29 22 45	122 13 16				
	Nimrod Sound: Middle islet	29 34 20	121 43 15				
	Tong-ting Islet: Summit	29 51 53	122 35 24				
	Chin-hai: Citadel	29 57 08	121 43 06				
	Ning-po: Square I. light	29 59 21	121 45 22	1 00	7 12	8.8	4.6
	Chusan Islands: Ting-hai Harbor	30 04 30	122 03 47				
	Video Island: Summit	30 08 04	122 45 48				
	West Volcano Island: Lighthouse	30 20 50	121 51 25				
	Chapu: Battery	30 36 00	121 03 00				
	Gutzlaff Island: Lighthouse	30 48 37	122 10 12				
	Saddle Islands: N. Saddle light	30 51 41	122 40 17				
	West Barren Island: Summit	30 44 07	123 08 27				
	Shanghai: Eng. consulate flagstaff	31 14 41	121 28 55				
	Woosung: Lighthouse	31 23 18	121 29 36	0 12	8 06	9.1	4.8
	Shaweishan Island: Lighthouse	31 25 27	122 14 12				
	Wang-kia-tia Bay: Langwang temple	35 39 00	119 51 30				
	Kiaochow Bay: Yunui San light	36 02 50	120 17 30	4 50	11 03	11.4	6.0
	Staunton Island: Landing place, N. side	36 45 29	122 16 48				
	Shantung Promontory: Lighthouse	37 24 00	122 42 00	4 00	10 12	6.8	5.0
	Weihaiwei: Light, S. side harbor	37 27 41	122 15 05	9 20	3 08	9.0	6.6
	Chifoo: Lighthouse	37 34 10	121 31 09	10 25	4 13	8.1	6.0
	Fort flagstaff	37 32 51	121 21 27				
	Miautao Island: Peak of N. Island	38 23 37	120 55 00				
	Pei Ho: S. Taku Fort, S. Cavalier	38 58 16	117 42 48				
	Tientain: Shore opp. NE. angle of wall	39 09 00	117 11 44	6 50	1 00	4.5	3.3
	Shaluitien Island: Lighthouse	38 56 00	118 31 00				
	Newchwang: Lightship	40 35 00	122 00 00	4 30	10 50	11.7	8.7
	Hulu-shan Bay: N. side	39 30 46	121 18 03				
	Port Adams: Entry	39 16 00	121 35 59				
	Liao-ti-shan Promontory: SW. pt. light	38 43 17	121 08 26				
	Ryojun Ko (P. Arthur): Obs. spot	38 47 50	121 15 54	10 05	3 53	7.5	5.5
	Dairen Wan: Isthmus on S. Sanshan I	38 52 38	121 51 59				
	Round Island: Summit	38 40 00	122 11 30				
	Thornton Haven, Hai-yun-tan Island: Beach opposite Temple Point	39 04 00	123 10 34				
	Pescadores Islands: Fisher I. light	23 32 53	119 28 05				
	Second pt. on N. side Makung Harbor	23 32 54	119 30 12				
Taiwan (Formosa).	South Cape: Lighthouse	21 55 00	120 51 00				
	Takau: Saracen Head	22 36 14	120 15 54	9 45	3 32	4.0	1.7
	Port Heongsan	24 46 00	120 55 00				
	Tamsui Harbor: White Fort	25 10 24	121 25 00	10 00	3 47	8.0	3.4
	Kiirun Ko (Kelung Hbr.): Lighthouse	25 09 12	121 44 28	10 15	4 03	3.0	1.3
	Soo (Sauo) Bay: Beach near village	24 35 28	121 49 20	6 00	12 13	5.8	2.5
	Botel Tobago Sima: S. extreme	22 01 40	121 39 45				
S. W. Islands of Japan.	Sakishima Gunto, Kumi I.: N. beach	24 26 00	122 56 00				
	(Meiaco Sima Is.) Broughton Bay: Landing place	24 21 30	124 17 40				
	Port Haddington: Hamilton pt.	24 25 00	124 06 40				
	Tai-pin-san: Hirara, Karimata Anch.	24 48 18	125 17 57	7 27	1 14	4.9	2.1
	Raleigh Rock: Summit, 270 ft.	25 55 00	124 35 00				
	Ti-ao-usu Island: Summit, 600 ft.	25 58 30	123 40 00				
	Hoa-pin-su Island: N. face	25 47 07	123 30 31				

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

EAST COAST OF ASIA—Continued.

Coast.	Place.	Lat. N.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
S. W. Isls. of Japan.	Nansei Shoto, Great Nansei: Nafa-Kiang.	26 12 25	127 40 10	6 30	0 15	5.8	2.5
	Yori-sima, 413 ft.	27 02 00	128 25 24				
	Yerabu-sima peak, 687 ft.	27 21 00	128 33 10				
	Kakirouma: Summit, 2,207 ft.	27 44 00	128 59 00				
	Iwo-sima: Volcano, 541 ft.	27 53 00	128 14 30				
	Oho-sima: N. extreme.	28 31 40	129 42 30				
	Kikai-jima: Summit, 867 ft.	28 18 00	129 59 00				
Tokara Is.	Kusakaki Jima: Ingersoll Rocks, 530 ft.	30 51 00	129 28 00				
	Kuro Sima: 2,160 ft.	30 50 00	129 55 30				
	Iwo Shima: Peak, 2,469 ft.	30 47 00	130 18 00				
	Yakuno Shima: Mount Matomi, 6,252 ft.	30 17 00	130 32 00				
	Firase Rocks: Highest, 92 ft.	30 05 00	130 03 00				
	Kuchino Shima: Summit, 2,230 ft.	29 59 00	129 56 00				
	Guaja Shima: Summit, 1,687 ft.	29 54 00	129 33 00				
	Naka no Shima: Peak, 3,400 ft.	29 52 00	129 52 30				
	Suwanose Jima: Volcano, 2,706 ft.	29 38 00	129 42 00				
	Tokara Jima: Summit, 860 ft.	29 08 00	129 13 30				
	Yoko Shima: Summit, 1,700 ft.	28 47 30	129 01 30				
Chosen (Korea).	Choda Island: S. pt.	38 27 00	124 34 40				
	Sir James Hall Islands: N. island	37 58 00	124 34 30				
	Chemulpo: So Wolmi.	37 27 40	126 36 27	4 19	10 31	28.8	11.6
	Marjoribanks Harbor: Manzoc Islet.	36 26 45	126 28 00				
	Tas de-foin Islet: Center.	36 24 30	126 24 00				
	Guerin Island: Summit, 969 ft.	36 07 00	126 01 09				
	Kokoun-tan Islands: Camp Islet.	35 48 08	126 31 00				
	Barren Island: Center, 600 ft.	35 21 00	125 58 00				
	Sea Rock: Center, 160 ft.	34 42 00	126 19 45				
	Modeste Island: N. peak, 1,228 ft.	34 42 30	125 16 00				
	Ross Island: Peak, 1,920 ft.	34 06 00	125 07 00				
	Kuper Harbor: NE. extreme of Josling I.	34 17 20	126 35 28				
	Port Hamilton: W. pt. of Obs. Island.	34 01 23	127 18 34	9 05	2 52	10.5	4.2
	Bate Islands: Summit Thornton Islet.	33 57 00	126 18 00				
	Montravel Island: Center, 1,041 feet.	33 59 00	126 55 00				
	Quelpart Island: Beaufort I., middle of W. side.	33 29 40	126 58 25				
	Observation Island: Point of W. arm.	34 39 00	128 14 00				
	Sentinel Island: Summit, 400 feet.	34 33 00	128 40 00				
	Broughton Head: Extreme.	34 48 00	128 44 00				
	Tsau-ling-hai Harbor: Lighthouse.	35 07 15	129 02 10	7 35	1 23	7.0	3.0
	Cape Clonard: Extreme.	36 05 45	129 33 30				
	Ping-hai Harbor.	36 36 00	129 20 00				
	Liancourt Rocks: Summit, 410 ft.	37 09 30	131 55 00				
	Matu Sima: Peak, 4,000 ft.	37 30 00	130 53 00				
	Port Lazaref: S. 1½ miles from the S. end of Bontenef I.	39 19 12	127 32 48				
Japan.	Tsu Sima: Observation rock.	34 18 55	129 13 06	8 56	2 44	6.7	2.4
	Iki Sima: Summit, S. end of island.	33 44 30	129 42 30				
	Oro No Sima: Summit, 277 ft.	33 52 10	130 02 00				
	Kosime No Osima: Summit Wilson I.	33 53 50	130 25 20				
	Yeboshi Sima: Lighthouse.	33 41 30	129 58 50				
	Yobuko Harbor: Bluff opposite Nicoya.	33 32 30	129 52 43	9 23	3 10	6.4	2.5
	Hirado No Seto: Taske light.	33 23 31	129 33 21				
	Goto Island: Ose Saki light.	32 36 45	128 36 10				
	Pallas Rocks: S. rock.	32 13 12	128 04 39				
	Meiaco Sima: Ears Peak.	32 03 00	128 25 00				
	Nagasaki: U. S. Transit Venus Station.	32 43 21	129 52 25	7 54	1 41	8.4	3.5
	Nezumi Jima: Obs. spot.	32 43 15	129 49 55	8 14		11.2	7.2
	Kuchinotsu: Lighthouse.	32 36 05	130 13 40				

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

EAST COAST OF ASIA—Continued.

Coast.	Place.	Lat. N.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Japan.	Kagoshima: Breakwater light	31 35 39	130 33 49	6 40	1 00	10.5	4.4
	Tsukarase Rocks: Summit, 96 ft	31 20 00	129 46 20				
	Uji Shima: High Peak, 1,097 ft	31 12 00	129 29 00				
	Yamagawa Harbor: Spit N. of town	31 12 43	130 37 00	7 20	1 08	9.5	3.9
	Satano Misaki: Lighthouse	30 59 30	130 39 30				
	Shimonoseki Strait: Meji Zaki, extreme	33 57 46	130 57 50				
	Rokuren Island: Lighthouse	33 58 53	130 52 07	8 30	2 20	6.7	2.4
	Shirasu Reef: Lighthouse	33 59 11	130 47 36				
	Susaki: SW. battery	33 23 19	133 17 00	5 55	12 08	5.0	2.0
	Tomo Roads: Tamatsu Sima	34 22 37	133 23 23	11 16	5 04	10.2	4.5
	Port Okayama: Take Sima temple	34 35 58	133 59 24				
	Wusimado Pt.: Wusimado Peak, 548 ft	34 37 27	134 09 21				
	Akashi-no-seto: Maico Fort	34 38 05	135 01 51				
	Hiogo: Wada Misaki light	34 39 20	135 10 56				
	Kobe: Lighthouse	34 41 18	135 11 34				
	Osaka: Fort Temposan light	34 39 45	135 26 00	7 30	1 25	4.7	2.0
	Sakai: Pier-head light	34 35 12	135 27 44				
	Osaki Bay: Tree Islet, S. pt	34 07 42	135 08 19				
	Yura No Uchi: Pier	33 57 34	135 07 21				
	Tanabe Bay: Fossil pt	33 41 14	135 23 04				
	Oŏ-sima Hbr.: Kashinosaki light, E. pt	33 28 15	135 51 59				
	Uragami Harbor: Village pt	33 33 37	135 54 25				
	Owashi Bay: Hikimoto	34 06 10	136 14 35				
	Mura Harbor: Osima Islet	34 13 52	136 48 51	6 23	0 10	4.7	2.0
	Matoya Harbor: Anori-saki light	34 21 57	136 54 09	5 52	12 04	4.3	1.7
	Omoi Saki: Lighthouse	34 35 52	138 13 49				
	Shimizu Bay: Mound on pt	35 00 51	138 31 19	5 52	12 04	3.9	1.6
	Mikomoto Island: Light house	34 34 25	138 56 30				
	Simoda Harbor: Center I	34 39 49	138 57 30				
	Yokosuka Harbor: Eyi Yama pt	35 17 30	139 39 43				
	Yokohama: Time-ball station	35 26 41	139 39 00	5 25	11 30	4.9	1.9
	Tokio: University Observatory	35 39 18	139 44 30				
	No Sima Saki: Lighthouse	34 54 17	139 53 24	5 04	11 17	3.7	1.4
	Vries Island (O Sima) Volcano: Summit, 2,512 ft	34 43 30	139 23 00				
	Kozu Shima Volcano: Summit, 2,000 ft	34 13 15	139 08 00				
	Mikake Jima: Summit, 2,690 ft	34 05 00	139 31 00				
	Redfield Rocks: S. rock	33 56 50	138 48 15				
	Mikura Jima: Summit	33 52 00	139 34 00				
	Broughton Rock: Summit, 60 ft	33 39 00	139 17 45				
	Fatsizio Island: Observation spot	33 04 24	139 50 24				
	Aoga Shima: Center	32 29 00	139 43 31				
	Bayonnaise Island: Summit, 26 ft	32 00 40	140 00 00				
	Smith Island: Summit, 250 ft	31 27 00	140 02 00				
	Ponafidin Island: Summit, 1,328 ft	30 28 26	140 14 02				
	Lots Wife Rock: Summit, 300 ft	29 46 28	140 19 40				
	Inaboye Saki: Lighthouse	35 42 13	140 52 22				
	Kinkwosan Island: Lighthouse	38 16 57	141 35 33				
	Kamaishi Harbor: SE. end of village	39 16 30	141 52 50				
	Yamada Harbor: Ko Sima, 90 ft	39 27 17	141 59 00	4 30	10 45	3.4	1.3
	Siriya Saki: Lighthouse	41 25 58	141 27 32				
	Toriwi Saki: Center of Low Islet off	41 33 34	140 56 36				
	Aomori: Lighthouse	40 50 00	140 44 40				
	Tatsupi Saki: N. side	41 16 17	140 22 37				
	Bittern Rocks: SW. rock	40 31 00	139 31 00				
	Tobi Shima: Takamori Yama	39 12 02	139 32 58				
	Awa Sima: NE. extreme	38 29 23	139 15 31				
	Sado Island: Ya Saki	38 19 55	138 27 09				
	Fushiki Harbor: Lighthouse	36 47 47	137 03 15				
	Cape Rokugo: Extreme	37 31 45	137 19 00				
	Niigata: Buddhist temple	37 55 14	139 03 01				
	Mana Sima: Summit, 200 ft	37 35 00	136 54 00				
	Manao Harbor: Sorenjo Pt	37 02 37	136 58 24				
	Tsuruga: Town	35 40 24	136 01 22	2 30	8 42	0.6	0.4

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

EAST COAST OF ASIA—Continued.

Coast.	Place.	Lat. N.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Japan.	Oki Islands: N. pt	36 30 00	133 23 00	....	....	....	.....
	Taka Yama (Cape Louisa): Extreme	34 40 00	131 36 00	11 41	5 28	1.1	0.5
	Ai Sima: Summit, 300 ft	34 32 00	131 18 00	....	....	....	.....
	Mino Sima: Summit, 492 ft	34 48 00	131 09 00	....	....	....	.....
	Kado Sima: Tsuno Shima light	34 21 12	130 50 29	....	....	....	.....
	Hakodate: Lightship	41 47 36	140 41 49	3 40	10 00	3.0	1.2
	Endermo Harbor: Bluff on E. side	42 19 54	140 59 33	3 32	9 45	3.5	1.5
	Okishi Bay: Lighthouse	42 56 52	144 52 38	3 41	9 53	3.0	1.4
	Noshiaf Saki: Lighthouse	43 22 56	145 49 10	3 48	10 00	3.1	1.4
	Nemuro: Benten Sima light	43 20 22	145 34 40	3 33	9 46	2.1	0.5
	Notsuke Anchorage: Village	43 33 11	145 18 00	4 50	11 05	3.7	1.8
	Noshiaf Misaki: Lighthouse	45 26 30	141 38 40	....	....	....	.....
	Risiri Islet: Peak, 5,713 ft	45 11 00	141 19 00	....	....	....	.....
Kuril Islands.	Kunashir Island: St. Anthonys Peak	44 20 00	146 15 00	....	....	....	.....
	Iturup Island: NE. pt	45 38 30	149 14 00	....	....	....	.....
	Urup Island: Cape Vanderlind	45 37 00	149 34 00	....	....	....	.....
	Broughton Island: Summit	46 42 30	150 28 30	....	....	....	.....
	Simusir Island: Prevost Peak	47 02 50	151 52 50	....	....	....	.....
	Ketoy Island: S. pt	47 17 30	152 24 00	....	....	....	.....
	Matana Island: Peak	48 06 00	153 12 30	....	....	....	.....
	Shiash-Kotan Island: Center	48 52 00	154 08 00	....	....	....	.....
	Kharim-Kotan Island: Peak	49 08 00	154 39 00	....	....	....	.....
	Oune-Kotan Island: SW. pt	49 19 00	154 44 00	....	....	....	.....
	Moukon rushi Island: Center	49 51 00	154 32 00	....	....	....	.....
	Porc musir Island: Fool's Peak	50 15 36	156 15 20	....	....	....	.....
	Soumshu Island: Center	50 46 00	156 26 00	....	....	....	.....
	Karafuto (S. Sakhalin):						
	C. Nortoro (Nishi Notoro Misaki) Light	45 53 10	142 04 51	....	....	....	.....
	C. Shiretoko (Nata Shiretoko Misaki)	46 01 20	143 26 30	....	....	....	.....
Siberia.	Sakhalin I., Cape Elizabeth: N. pt	54 24 30	142 46 30	11 20	5 08	4.2	1.7
	Wawoda Rock: Summit, 12 ft	42 14 30	137 17 00	....	....	....	.....
	Expedition Bay: Lighthouse	42 38 05	130 48 45	....	....	....	.....
	Port Novogorod: Lighthouse	42 33 40	131 10 00	....	....	....	.....
	Vladivostok: Cape Goldobin light	43 05 13	131 52 46	2 45	9 00	1.9	0.8
	Cape Povorotnyi: Lighthouse	42 41 00	133 02 00	....	....	....	.....
	Port Olga: Lighthouse	43 22 00	135 15 00	....	....	....	.....
	St. Vladimir Bay: Orekhera Pt	43 53 40	135 27 19	....	....	....	.....
	Shelter Bay	44 30 00	136 02 00	....	....	....	.....
	Sybillo Bay	44 43 45	136 22 30	....	....	....	.....
	Pique Bay	44 46 15	136 27 15	....	....	....	.....
	Bullock Bay	45 05 00	136 44 00	....	....	....	.....
	Luke Point: Extreme	45 19 30	137 10 15	....	....	....	.....
	Cape Disappointment: Extreme	45 41 30	137 38 15	....	....	....	.....
	Cape Suffren: Extreme	47 20 00	138 58 00	....	....	....	.....
	Cape St. Nikolaia: Lighthouse	48 59 30	140 23 40	9 50	3 40	2.7	1.1
	De Kastri: Lighthouse	51 28 00	140 48 00	10 45	4 40	6.3	2.6
	Nikolaevsk: Cathedral	53 08 05	140 42 58	....	....	....	.....
	Great Shantar Island: N. pt	55 11 00	137 40 00	....	....	....	.....
	Port Aian: Cape Vneshni	56 25 28	138 25 50	0 10	7 30	8.4	3.4
	St. Jona Island: Summit, 1,200 ft	56 22 30	143 15 45	....	....	....	.....
	Okhotsk: Battery	59 19 45	143 07 14	....	....	....	.....
	Cape Lopatka: Extreme	51 02 00	156 46 00	3 55	10 08	4.6	1.9
	Petropavlovsk: Rakof light	52 52 37	158 46 42	3 30	9 45	5.1	2.1
	Cape Shipunski: Extreme	53 04 30	160 04 00	....	....	....	.....
	Bering Island: Cape Khitroff	54 56 00	166 43 00	....	....	....	.....
	Mednoi, or Copper Island: SE. extreme	54 32 24	168 09 00	....	....	....	.....
	Cape Kamchatka: Extreme	56 10 00	163 24 00	....	....	....	.....
	Karajinski Island: S. pt	58 26 00	163 34 00	....	....	....	.....
	Cape Oliutorski: Extreme, 2,480 ft	59 55 00	170 22 00	6 00	12 15	4.5	1.8
	Cape Navarin: Extreme, 2,512 ft	62 14 30	179 04 30	....	....	....	.....

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

EAST COAST OF ASIA—Continued.

Coast.	Place.	Lat. N.	Long. W.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Siberia.	St. Matthew Island: Cape Upright, SE. pt.	60 18 00	172 04 00				
	St. Lawrence Island: N. pt.	63 12 00	159 50 00				
	Cape Tchoukotskio: Extreme	64 16 00	173 10 00				
	Port Providence: Emma Harbor	64 25 55	173 07 15				
	Cape Indian: Extreme	64 24 30	172 12 30				
	Arakam Island: Cape Kiguinin	64 46 00	172 07 00				
			Long. E.				
	Anadir River: Mouth	64 50 00	178 40 00				
			Long. W.				
	Cape Bering: Extreme	65 00 30	175 54 00				
	East Cape: Extreme	66 02 00	169 32 30				

ISLANDS OF THE PACIFIC.

Coast.	Place.	Lat. N.	Long. W.	H. W.	L. W.	Spg.	Neap.
	Malpelo Island: Summit, 1,200 ft.	4 03 00	81 36 00				
	Cocos Island: Head of Chatham Bay	5 32 57	86 59 17				
Galapagos Islands.	Redondo Rock: Summit, 85 ft.	0 13 30	91 03 00				
	Towers Island: W. cliff	0 20 00	89 58 43				
	Bindloe Island: S. summit	0 18 50	90 30 08				
	Abingdon Island: Summit, 1,950 ft.	0 34 25	90 44 23				
	Wenman Island: Summit, 550 ft.	1 22 55	91 49 43				
	Albemarle Island: Iguana Cove	0 59 00	91 29 12	2 00	8 13	6.2	3.1
	Marlborough Island: Cape Hammond	0 31 00	91 36 00				
	James Island: Sugarloaf, 1,200 ft.	0 15 20	90 52 53	2 45	8 58	5.2	2.6
	Jervis Island: Summit	0 25 00	90 43 30				
	Duncan Island: Center hill	0 36 30	90 41 00				
	Indefatigable Island: NW. bay	0 33 25	90 33 58	2 00	8 13	6.2	3.1
	Barrington Island: W. summit, 900 ft.	0 50 30	90 06 13				
	Charles Island: Summit, 1,780 ft.	1 19 00	90 28 13	2 10	8 23	6.0	3.0
	Fatu Huku or Hood Island: E. summit, 640 ft.	1 25 00	89 40 08				
	Chatham Island: Mount Pitt, 800 ft.	0 44 15	89 16 58	2 20	8 33	6.5	3.3
	Christmas Island: N. pt. of Cook Islet	1 57 17	157 27 45	4 25	10 38	2.4	1.4
	Fanning Island: Flagstaff, entrance to English Hbr.	3 51 26	159 21 50	6 00	12 15	2.4	1.4
	Washington Island	4 41 10	160 24 30				
	Palmyra Island	5 52 15	162 05 00	5 25	11 40	1.5	0.9
	Baker Islet: Center	0 13 30	176 32 39				
	Howland Islands: Center island	0 49 00	176 43 09	7 10	1 00	6.2	3.6
Gilbert Islands.		Lat. S.	Long. E.				
	Arorai or Hurds Island: S. pt.	2 40 54	177 01 13				
	Tamana Island: Center	2 35 00	176 07 00				
	Onoatoa Island: Center	1 50 00	175 39 00				
	Taputeuea or Drummond Island: SE. pt.	1 29 14	175 12 20				
	Nukunau or Byron Island: SE. pt.	1 23 42	176 31 33				
	Peru or Francis Island: NW. pt.	1 17 14	175 57 09				
	Nonuti or Sydenham Island	0 36 00	174 24 00				
		Lat. N.					
	Aranuka or Henderville Island: W. pt. of W. island	0 11 10	173 32 40				
	Apamama or Hoppers Island: Entrance islet	0 20 54	173 51 14	4 30	10 45	4.7	2.7
	Maiana Island: S. pt.	0 51 30	173 03 30				
	Tarawa Island: NE. pt.	1 38 45	173 03 00				
	Apaiang Island: S. pt.	1 44 15	173 07 00	4 45	11 00	4.7	2.7
	Maraki Island: N. pt.	2 03 00	173 25 30				
	Taritari Island: S. pt.	3 01 30	172 45 40				

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

ISLANDS OF THE PACIFIC—Continued.

Coast.	Place.	Lat. N.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Marshall Islands.	Ebon Atoll: Rube Pt	4 35 25	168 41 31	4 45	11 00	4.7	2.7
	Jaluit or Bonham Islands: Jarbor Pier	5 55 07	169 39 31				
	Burrh Island: Port Rhin, N. pt. of entrance	6 14 00	171 46 00	5 00	11 15	5.0	2.8
	Majuro or Arrowsmith Islands: Anchorage Djarrit I	7 05 30	171 24 30				
	Arno Atoll: NE. pt	7 09 17	171 55 51				
	Odia Islands: S. islet	7 15 00	168 46 00				
	Namu Island: S. pt	8 14 00	168 03 00				
	Jabwat Island: Center	8 27 00	168 26 00				
	Aurh or Ibbetson Island: NE. end, anchorage	8 19 00	171 09 00				
	Maloclab Islands: NW. end Karen Islet	8 54 21	170 49 00				
	Wotje or Romanzov Islands: Christmas Harbor	9 28 09	170 16 05				
	Litkieh Island: NW. pt	10 03 40	169 01 57				
	Ailuk Islands: Capeniur Islet	10 17 25	169 59 20	4 50	11 00	6.2	3.6
	Bigar Islet: Center	11 48 00	170 07 00				
	Kongelab or Pescadores Islands: Center of group	11 19 21	167 24 57				
	Rongerik or Radakala Islands: Observation spot	11 24 00	167 35 00				
	Ailinginae Island: Easternmost Islet	11 07 00	166 35 00				
	Bikini or Eschholtz Islands: W. extreme	11 40 00	166 24 25				
	Wottho or Schanz Island: Center	10 05 00	166 04 00				
	Eniwetok Islands: North or Engibi I	11 40 00	162 15 00				
	Ujelang or Providence Island: Center of atoll	9 39 00	161 08 30				
	Greenwich Island: Northern islet	1 04 00	154 47 55				
Caroline Islands.	Matelotas group: Easternmost of the S. islands	8 18 30	137 33 30				
	Yap Island: Light in Tomil Bay	9 29 00	138 04 00	7 15	1 00	3.4	1.9
	Eau Island: Center	9 52 30	139 42 00				
	Uluthi or Mackenzie Islands: Mogmog Islet	10 06 00	139 46 00				
	Feys or Tromelin Island: E. extreme	9 46 00	140 35 00				
	Sorol or Philip Island: Center	8 06 00	140 52 00				
	Eauripik or Kama Islands: E. islet	6 40 00	143 11 00				
	Oleai group: Raur Islet, N. pt	7 21 45	143 57 30				
	Ifalik or Wilson Islets: N. end	7 15 00	144 31 00				
	Faraulep Island: S. end	8 35 00	144 36 00				
	W. Faiu Islet: Center	8 03 00	146 50 00				
	Olimarao Islet: Center	7 43 30	145 55 45				
	Toass Island: Center	7 29 30	146 24 30				
	Satawal Island: Center	7 22 00	147 06 48				
	Coquille or Pikelot Island: Center	8 09 00	147 42 00				
	Suk or Polusuk Island: S. end	6 40 00	149 21 00				
	Los Martires: Ollap Islet, N. pt	7 38 00	149 27 30				
	Namonuito Islands: Magur Islet	8 59 45	150 14 30				
	Hall Island: Namuine Islet	8 25 30	151 49 15				
	Hogolu (Hogulu) Group: N. end of Tsis Islet	7 18 30	151 56 30				
	Namoluk Islands: NW. islet	5 55 00	153 13 30				
	Mortlock Islands: Lukanor, Port Chamisso	5 29 18	153 58 00				
	Nukuor or Monteverde Islands: E. pt	3 51 00	155 00 54				
	Oraluk or Bordelaise Island: Center	7 39 00	155 05 00				
	Ngatik or Valientes Islands: E. extreme	5 48 00	157 31 30				
	Ponapi Island: Ponapi Harbor	7 00 35	158 17 35	4 00	10 15	4.3	2.4
	Mokil or Duperrey Islands: Aoura, NE. pt	6 41 45	159 50 00				
	Pingelasp or MacAskill Islands: E. end of island	6 14 00	160 38 43				
	Ualan or Strong Island: Chabrol Harbor	5 20 06	163 00 45	6 00	12 15	3.5	2.0

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

ISLANDS OF THE PACIFIC—Continued.

Coast.	Place.	Lat. N.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Pelew Islands.	Angaur Island: SW. pt	6 53 55	134 05 24				
	Pililu Island: S. pt	7 02 00	133 18 03				
	Earakong or Akamokan Islands: Center	7 08 00	134 27 00				
	Korro Islands: Korror Harbor, Malakal pier	7 19 00	134 32 30				
	Baubeltaub Island: Cape Artingal	7 40 30	134 39 30				
	Kyangle Islets: Center of largest	8 08 00	134 17 00				
	Warren Hastings Island: Center	4 20 00	132 21 00				
	Nevil or Lord North Island: Center	3 02 00	131 11 00				
	Sonserol Island: Approx	5 20 00	132 16 00				
Marianas (Ladrone Is.).	Guam: Fort Sta. Cruz, Harbor of Apra	13 26 22	144 39 42	7 20	1 20	2.6	1.5
	Rota Island: Summit	14 07 30	145 13 04				
	Tinian Island: Sunharon village	14 59 22	145 36 20				
	Saipan Island: Magicienne Bay, landing	15 08 30	145 43 55				
	Tanapag Hbr., Garapag	15 17 10	145 42 50	7 00	0 50	2.0	1.1
	Anataxan Island: Center	16 20 00	145 39 00				
	Sariguan Island: Center	16 41 00	145 47 00				
	Guguan Island: Center	17 17 00	145 57 00				
	Alamaguan Island: Center	17 36 00	145 55 00				
	Pagan Island: SW. pt	18 04 00	145 52 00				
	Agrigan Island: SE. pt	18 46 20	145 41 45				
	Asuncion Island: Crater, 2,600 ft	19 45 00	145 30 00				
	Urracas Islands: Largest islet	20 00 00	145 21 00				
	Farralon de Pajaros: S. end	20 32 54	144 54 00				
	Wake Island: Obs. spot	19 15 00	166 31 30				
	Gaspar Rico Reef: N. clump of rocks	14 41 00	168 54 28				
			Long. W.				
	Johnston or Cornwallis Islands: Flagstaff on W. island	16 44 48	169 32 24				
	Clipperton Island: Center	10 17 00	109 13 00				
Hawaiian Islands.	Hawaii Island: Hilo, Kanaha Pt. light	19 46 14	155 05 31	3 09	9 06	2.3	1.3
	Kawaihae light	20 03 00	155 48 00				
	Kealakeakua Bay light	19 28 00	155 55 00	2 20	8 10	1.6	0.9
	Kailua, stone church	19 38 26	156 00 15				
	Kahoolawe Island: Summit	20 33 39	156 35 04				
	Maui Island: Kanahena Pt. light	20 36 00	156 26 00				
	Lahaina light	20 52 00	156 35 00	3 32	9 58	2.2	1.2
	Molokai Island: Lighthouse	21 06 17	157 18 32	2 38	8 56	2.1	1.1
	Oahu Island: E. pt. Makapuu station	21 18 16	157 39 07				
	Diamond Head	21 15 08	157 48 44				
	Honolulu, Tr. of V. Obs	21 17 57	157 51 34				
	Honolulu, Reef light	21 17 55	157 51 54	3 46	9 59	1.5	0.8
	Kauai Island: Hanalei, Black Head	22 12 51	159 30 47				
	Waimea, stone church	21 57 17	159 40 08	4 00	10 20	2.0	1.1
	Bird Island: Center	23 05 50	161 58 17				
	Necker Island: Center	23 35 18	164 40 47				
	French Frigate Shoal: Islet (120 ft.)	23 46 00	166 17 57				
	Gardiner Island: Center	25 00 40	168 00 52				
	Maro Reef: NW. pt	25 31 00	170 39 20				
	Laysan Island: Lighthouse	25 48 00	171 44 00				
	Lisiansky Island: Lighthouse	26 00 00	173 57 00				
	Pearl and Hermes Reef: NE. extreme	27 56 30	175 46 00				
	Midway Islands: Lighthouse, Sand I	28 13 15	177 21 30	3 30	9 45	1.1	0.6
	Ocean Island: Sand Islet	28 24 45	178 27 45				
			Long. E.				
	Marcus Island: Center	24 14 00	154 00 00				

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

ISLANDS OF THE PACIFIC—Continued.

Coast.	Place.	Lat. N.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
	Ogasawara Is. (Bonin Is.), Parrys Group: N. rock	27 45 00	142 06 53				
	Kater Island: N. rock	27 31 00	142 11 53				
	Peel Island: Port Lloyd, observatory	27 05 37	142 11 23	6 10	0 00	2.4	1.4
	Volcano Is., San Alessandro or North Island: Center	25 14 00	141 11 00				
	Sulphur Island	24 48 00	141 13 00				
	San Augustine Island: Center	24 14 00	141 20 00				
	Rosario Island: Center, 148 ft	27 15 32	140 50 28				
	Douglass Rocks: Center	20 30 00	136 10 00				
	Borodino Islands: Center of N. island	25 59 38	131 19 30				
	Center of S. island	25 52 45	131 12 17				
	Rasa Island: Center	24 27 00	131 01 50				
		Lat. S.	Long. W.				
Marquesas Islands.	Fatu Hiva Island: S. pt	10 32 00	138 39 20				
	Motane Island: SSE. pt	10 01 40	138 48 30				
	Tahuata Island: Port Resolution, watering place	9 56 00	139 09 00	2 30	8 45	3.1	1.9
	Hiva-Oa Island: C. Balguerie	9 45 00	138 47 40				
	Fatu Huku Island: Center	9 27 30	138 55 10				
	Roa Poua Island: Obelisk Islet	9 29 30	140 04 45				
	Nuka-Hiva Island: Port Tai-o-hae light	8 55 13	140 04 00	3 50	10 05	3.5	2.1
	Hiaou Island: S. pt	8 03 30	140 44 00				
	Motu-ili Island: Summit, 130 ft	8 44 00	140 38 30				
	Ua-Huka or Ua-Una Island: N. pt	8 54 00	139 33 30				
	Fetouhouhou Island: NE. pt	7 55 00	140 34 40				
	Caroline Islands: Solar Eclipse Transit Pier	10 00 01	150 14 30	4 00	10 14	1.1	0.7
	Vostok Island: Center	10 06 00	152 23 00				
	Flint Island: S. extremity	11 25 23	151 48 34				
	Malden Island: Flagstaff, W. side	4 03 00	155 01 00				
	Starbuck Island: Flagstaff, W. side	5 37 00	155 56 00				
	Penrhyn or Tongarewa Island: NNW. pt	8 55 15	158 07 00	6 00	12 15	1.5	0.9
	Jarvis Island: Center	0 22 33	159 54 11				
	Reirson Island: Church	10 02 00	161 05 30				
	Humphrey Island: N. pt	10 20 30	161 01 12				
	Union or Tokelau Islands: Spot N. of Fakaofu or Bowditch Islet	9 23 02	171 14 46	6 00	12 13	2.4	1.4
	Union or Tokelau Islands: Nuku-nono, or SE. island, Duke of Clarence I	9 13 06	171 44 40				
	Union or Tokelau Islands: Clump on S. island, Oatafu or Duke of York I	8 39 40	172 28 10				
Phœnix Is.	Canton or Mary Island: N. pt	2 44 25	171 45 29				
	Enderbury Island: W. pt	3 08 30	171 10 00	5 00	11 15	4.6	2.7
	Phœnix Island, N. pt	3 42 28	170 42 37				
	Birneys Island: S. pt	3 34 15	171 32 07				
	Gardners Island: Center	4 37 42	174 40 18				
	McKean Island: Center	3 35 10	174 17 26				
	Hulls Island: W. pt	4 30 95	172 13 28				
			Long. E.				
Ellice Islands.	Mukulaelae or Mitchells Island: S. pt	9 18 00	179 50 00				
	Funafuti or Ellice Island: E. pt	8 25 19	179 07 25				
	Nukufetau or De Peysters Island: S. pt	8 04 02	178 28 51				
	Vaitupu Island: S. end	7 32 00	178 41 01				
	Nui or Netherland Island: S. pt	7 15 45	177 16 50				
	Nanomaga Island: Center	6 12 00	176 16 30				
	Niutao Island: Church	6 06 00	177 20 01				
	Nanomea Island: Center	5 39 00	176 06 15				

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

ISLANDS OF THE PACIFIC—Continued.

Coast.	Place.	Lat. S.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
	Ocean or Paanopa Island: Center (appx.)	0 52 00	169 35 00				
	Pleasant Island: Center	0 25 00	167 05 00				
	Indispensable Reefs: S. pt. of S. reef	12 50 15	160 26 00				
	Rennel Island: SE. extreme	11 52 15	160 40 15				
	W. end	11 33 45	159 55 00				
Solomon Islands	San Cristoval Island: Point Wangalaha	10 17 32	161 33 30	6 45	0 33	3.3	2.0
	Guadalcanal Island: Wanderer Bay, mouth of Boyd Creek	9 41 47	159 39 30				
	Florida Island: Mboli Harbor, Tree Islet	9 01 30	160 27 20				
	Malaita Island: Village, Mary I., Port Adam	9 30 00	161 27 40				
	Stewart Islands: Largest islet	8 23 00	162 58 15				
	Isabel Island: N. side of Cockatoo Islet	8 30 50	159 38 20	5 00	11 15	3.5	2.1
	Gizo or Shark Island: N. point village	8 05 40	156 50 15				
	Choiseul Island: Choiseul Bay entrance	6 42 40	156 23 16				
	Treasury Islands: Observation Islet	7 24 30	155 34 00				
	Bougainville Island: Husker Pt., Gazelle Harbor	6 35 00	155 05 00	12 00	5 47	2.7	1.6
	Buka Island: Cape North	5 00 00	154 35 00				
	Lord Howe Group: Center, small SW. islet	5 38 00	159 21 00				
	Center, small NE. islet	5 18 00	159 34 00				
	NW. pt. of Hammond I	5 18 00	159 17 00				
	Neu Pommern (New Britain), Blanche Bay: Matupi I. N. pt	4 14 12	152 11 35	9 00	2 45	2.1	1.3
	Duke of York Island: Makada Harbor, Spit Pt	4 06 25	152 06 15				
	Neu Mecklenburg (New Ireland): Carteret Harbor, Cocoanut I	4 41 26	152 42 25				
	Katharine Haven	3 11 00	151 35 30				
	Holz Haven, E. side	2 47 30	150 57 35	2 50	9 03	2.4	1.4
	New Hanover Island: Water Haven, creek mouth	2 33 43	150 04 33				
	North Haven anchorage	2 26 30	149 55 36	2 30	8 43	2.4	1.4
	St. Matthias Island: SW. extreme	1 35 00	149 37 00				
Admiralty Is.	Admiralty Island: Nares Harbor, obs. islet	1 55 10	146 40 56				
	St. Andrew Island: Violet Islet, 60 ft	2 25 40	147 28 35				
	Jesus Maria Island: SE. pt	2 22 00	147 55 00				
	Commerson Island: Center of largest islet	0 45 00	145 17 00				
	Anchorite Island: N. pt	0 53 15	145 33 04				
	Hermit or Loaf Island: Pemé Islet	1 28 00	145 08 00				
	Purdy Island: Mole Islet	2 51 00	146 15 00				
New Guinea Island.	Point d'Urville: extreme	1 25 40	135 28 12				
	Drei Cap Peninsula: Wass Islet	2 44 00	132 04 00				
	Triton Bay: Fort Dubus, Dubus Haven	3 47 00	134 06 00	0 55	7 08	7.3	4.3
	Cape Walsche: Extreme	8 22 00	137 40 00				
	Fly River: Free Islet, S. pt	8 41 00	143 36 04				
	Port Moresby: N. end of Jane I	9 25 30	147 07 04	8 50	2 38	8.0	4.8
	Cape Rodney: Extreme	10 14 30	148 30 30				
	South Cape: S. pt. Su Au I	10 43 35	150 14 20	9 15	3 00	8.1	4.8
	Hayter Island: W. end	10 37 00	150 40 34	8 25	2 12	5.8	3.4
	Cape Cretin: Cretin Islets	6 43 00	147 53 20				

MARITIME POSITIONS AND TIDAL DATA.

ISLANDS OF THE PACIFIC—Continued.

Coast.	Place.	Lat. S.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Louisiade Arch.	Trobriand Islands: NE. pt. Cape Denis	8 24 00	151 01 24	4 45	10 58	3.0	1.8
	Woodlark Islands: N. pt	9 03 30	152 47 00	7 05	0 53	4.2	2.5
	D'Entrecasteaux Is.: Ferguson I., SW. extreme	9 38 00	150 30 00				
	Well Island, E. pt	9 41 00	150 58 00				
	Normanby I., obs. islet	9 43 53	150 44 43				
	St. Aignan Island: Summit	10 42 00	152 42 04				
	Renard Islands: W. pt	10 52 40	152 47 12				
	Rossel Island: E. pt	11 23 25	154 08 00				
	Adele Island: S. extreme	11 29 10	154 25 14				
Coral Sea Arch.	Coringa Islands: Chilcott Islet	16 50 00	149 58 00				
	Herald Cays: NE. Cay	16 55 50	149 11 54				
	Tregosse Islands: S. islet	17 43 00	150 42 04				
	Lhou Reef: Observation Cay	17 07 20	152 06 20				
	Mellish Reef: Cay beacon	17 24 39	155 52 24				
	Bampton Island	19 08 00	158 40 00				
	Renard Island: Center	19 14 00	159 00 00				
	Wreck Reef: Bird Islet	22 10 30	155 28 24				
	Cato Island: Center	23 15 02	155 33 04				
Santa Cruz Islands.	Duff or Wilson Group: N. island	9 48 00	166 53 15				
	Matema or Swallow Group: Nimanu Islet	10 21 00	166 17 15				
	Tinakula Island: Summit, 2,200 ft	10 23 30	165 47 30				
	Nitendi Island: NE. pt., Cape Byron	10 40 00	166 00 30				
	Tapua Island: Basilisk Harbor, S. pt. of entrance	11 17 30	166 32 14				
	Vanikoro: Ocili village	11 40 24	166 57 45	4 50	11 05	3.8	2.3
New Hebrides Islands.	Torres or Ababa Island: Hayter Bay, Middle I	13 15 00	166 33 00				
	Vanua Lava Island: Port Patterson, Nusa Pt	13 48 00	167 30 31	6 40	0 30	3.8	2.3
	Santa Maria Island: Lasolara Anchorage	14 11 00	167 30 00				
	Aurora Island: Laka-rere	14 58 00	168 02 00				
	Mallicollo Island: Port Sandwich, pt. on E. side	16 26 00	167 47 15	4 38	10 50	3.8	1.9
	Vate or Sandwich Island: Havannah Harbor, Matapou Bay flagstaff	17 44 58	168 18 50	5 15	11 27	3.0	1.8
	Erromango Island: Dillon Bay, Pt. Williams	18 47 30	168 58 00				
	Tanna Island: Port Resolution, Mission	19 31 17	169 27 30				
	Erronan or Futuna Island: NW. pt	19 31 20	170 11 15				
	Aneityum Island: Port Anatom, Sand Islet	20 15 17	169 44 45	5 10	11 23	3.1	1.9
	Matthew Island: Peak, 465 feet	22 20 12	171 20 30				
	Hunter Island: Peak, 974 feet	22 24 02	172 05 15				
	Walpole Island: S. pt	22 38 07	168 56 45				
	Mitre Island: Center	11 55 00	170 10 00				
	Rotumah Island: Epipigi Peak	12 30 10	177 07 15	6 15	0 00	4.2	2.5
Fiji Islands.	Kandavu Island: N. rock Astrolabe Reef light	18 38 15	178 32 15				
	Mt. Washington, N. peak	19 07 09	177 57 09				
	Ngaloa Harbor, outer beacon	19 05 30	178 10 24	6 40	0 25	4.0	2.4
	Vatu Lele Island: S. pt	18 36 00	177 38 00				
	Ovalau Island: Levuka lighthouse	17 40 45	178 49 00				

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

ISLANDS OF THE PACIFIC—Continued.

Coast.	Place.	Lat. S.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Fiji Islands.	Viti Levu Island: Summit of Malolo Islet.	17 44 45	177 09 00				
	Suva Harbor, low light.	18 06 50	178 24 40	6 30	0 15	3.6	2.2
	Mbega or Mbengha Island: Swan Harbor, Leaven Pt.	18 22 00	178 06 53				
	Matuku Island: N. side of Matuku entrance	19 09 38	179 44 27				
	Moala Island: Rocks off N. pt	18 32 49	179 56 25				
	Ngau Island: Herald Bay, E. side	17 59 32	179 14 08				
	Wakaya Island: Rocky Peak	17 37 11	178 59 29				
	Makongai Island: Dilliendreti Peak	17 27 14	178 57 46				
	Goro Island: NW. pt	17 15 21	179 20 44				
	Vanua Levu Island: Mount Dana	16 42 01	178 54 15				
	Nandi, observation islet	16 57 53	178 48 32				
	Savu Savu Pt., extreme	16 49 19	179 16 08	6 00	12 13	4.3	2.6
			Long. W.				
	NE. Pt	16 08 00	179 58 46				
	Taoiuni Island: Somu-Somu town	16 46 00	179 51 00				
	Thikombia Island: E. hummock	15 44 45	179 54 26				
	Naitamba Island: Center	17 03 00	179 17 00				
	Vatu Vara Island: N. end; summit	17 25 33	179 32 17				
	Kanathea Island: S. pt	17 17 20	179 10 00				
	Vanua Mbalavu Island: NW. pt	17 10 00	179 05 45				
	Mango Island: Pier end	17 25 26	179 10 33	6 10	0 00	3.1	1.9
	Thithia Island: Highest peak	17 44 12	179 19 49				
	Tuvutha Island: Peak	17 39 33	178 50 27				
	Naian Island: Summit, 580 ft	17 59 00	179 04 00				
	Lakemba Island: Kendi Pt	18 14 10	178 52 00				
	Oneata Island: Summit of Loa I	18 25 46	178 27 04				
	Mothe Island: Summit	18 38 56	178 30 54				
	Mamuka Island: Center, 260 feet	18 46 00	178 44 00				
	Kambara Island: Highest peak	18 56 15	178 59 05				
	Totoya Island: Black Rock Bay, W. side.	18 58 57	179 52 58	6 35	0 20	3.5	2.1
	Fulanga Island: W. bluff	19 03 00	178 47 25				
	Ongea Levu Island: Center	19 04 00	178 33 25				
	Vatoa or Turtle Island: Hummock	19 49 11	178 13 38	6 10	0 00	3.1	1.9
	Ono Islands: Peak	20 39 10	178 43 27				
	Michaeloff Island: Center	21 00 09	178 44 03				
	Simonoff Island: Center	21 01 39	178 49 47				
	Fatuna or Horne Island: Mt. Schouten	14 14 20	178 06 45				
	Uea or Wallis Island: Fenua-fu Islet	13 23 35	176 11 47	6 40	0 28	4.4	2.7
	Niua-fu or Good Hope Island: NW. extreme	15 34 00	175 40 40				
	Keppel Island: Center	15 52 00	173 52 00				
	Boscawen Island: Center	15 58 00	173 52 00				
Samoa Is.	Savaii Island: Paluale village	13 45 00	172 17 00				
	Upulo Is.: Apia Harbor, obs. spot	13 48 56	171 44 56	6 25	0 13	3.1	1.9
	Tutuila Island: Pago-Pago, obs. pt	14 18 06	170 42 14	7 00	0 45	2.7	1.6
	Manua Island: Village, NW. side	14 19 00	169 32 00	6 00	12 13	4.6	2.7
	Rose Island: Center	14 32 00	168 09 00				
	Niue or Savage Island: S. pt	19 10 00	169 50 00				
	Danger, or Bernardo, Is.: Middle rock	10 52 47	165 51 30				
	Suwarrow or Souwaroff Island: Cocoanut Islet	13 14 30	163 04 10	3 10	9 23	2.4	1.4
	Palmerston Islands: W. islet	18 05 50	163 10 00				
	Scilly Islands: E. islet	16 28 00	154 30 00				
	Bellingshausen Island: Center	15 48 00	154 31 00				
	Mopelia (Lord Howe) Island: Center	16 52 00	154 00 00				

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

ISLANDS OF THE PACIFIC—Continued.

Coast.	Place.	Lat. S.	Long. W.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Society Islands.	Maitea Island: Summit	17 53 00	148 05 00				
	Tahiti Island: Lighthouse	17 29 10	149 29 00	12 00	5 48	1.0	0.6
	Tubuai-Manu or Maia-iti I.: NW. pass	17 36 39	150 36 56				
	Eimeo Island: Talu Hbr., Vincennes Pt	17 29 23	149 50 30				
	Huaheine Island: Lighthouse	16 42 30	151 01 28				
	Ulietea Island: Regent Pt	16 50 00	151 27 21				
	Tahoa Island: Center	16 35 00	151 35 00				
	Bola-Bola Island: Otea-Vanua village	16 31 35	151 46 00	12 10	6 00	1.4	0.8
	Tubai or Motu-iti Island: N. pt. of reef	16 11 00	151 48 00				
	Marua or Maupili Island: Center	16 26 00	152 12 00				
Tuamotu Archipelago.	Ducie Island: NE. entrance	24 40 20	124 48 00				
	Pitcairn Island: Village	25 03 50	130 08 30				
	Henderson or Elizabeth Island: Center	24 21 20	128 19 00				
	Oeno Island: N. pt	24 01 20	130 41 00				
	Mangareva or Gambier Island: Flagstaff	23 07 36	134 57 54	1 50	8 03	2.4	1.4
	Marutea or Lord Hood Island: Center	21 31 30	135 33 05				
	Maria or Moerenhout Island: Center	22 01 00	136 10 15				
	Vahanga Island: W. pt	21 20 00	136 38 53				
	Morane or Cadmus Island: Center	23 07 50	137 06 15				
	Tureia or Carysfort Island: E. pt	20 46 20	138 27 45				
	Mururoa or Osnabrug Island: Obs. spot	21 50 00	138 56 30				
	Tematangi or Bligh Island: N. pt	21 38 00	140 38 45				
	Nukutipipi: SW. pt	20 43 00	143 03 15				
	Hereheretue or St. Paul Island: Center	19 53 17	144 57 00				
	Vanavana or Barrow Island: Center	20 46 07	139 08 45				
	Nukutavake or Queen Charlotte I.: N. pt.	19 16 30	138 48 30				
	Reao or Clermont Tonnere Island: NW. point	18 00 29	136 26 30				
	Puka-ruha or Serles Island: NW. pt	18 16 00	137 03 30				
	Vahitahi Island: W. pt	18 43 30	138 53 15				
	Ahunui or Byam Martin Island: NW. pt.	19 37 00	140 15 45				
	Pinaki or Whitsunday Island: E. pt	19 25 00	138 40 45				
	Tatakoto or Clerke Island: Flagstaff on western coast	17 19 30	138 26 26				
	Hao or La Harpe Island: NW. pass	18 05 20	140 59 30	2 40	8 55	2.4	1.4
	Paraoa or Gloucester Island: Center	19 08 45	141 41 10				
	Ravahere Island: S. pt	18 18 30	142 11 31				
	Reitoru or Bird Island: N. beach	17 49 35	143 05 23				
	Hikueru or Melville Island: E. pt	17 35 28	142 35 16				
	Tauere Island: NW. pt	17 20 30	141 29 43				
	Puka-puka Island: E. pt	14 49 00	138 46 45				
	Napuka Island: W. pt	14 12 00	141 15 37				
	Angatau or Araktcheff Island: W. pt	15 50 00	140 53 35				
	Tukume or Wolkonsky Island: NW. pt	15 44 20	142 08 40				
	Tuanske Island: NW. pt	16 39 10	144 14 45				
	Nihiru Island (Tuanake): SW. pt	16 44 29	142 53 34				
	Anaa Island: Islet in N. pass	17 20 20	145 30 54				
	Tepoto Island: N. pt	16 47 49	144 17 18				
	Haraiki or Crocker Island: SW. pt	17 28 41	143 31 17				
	Makemo or Phillips Island: W. pass	16 26 09	143 57 59				
	Fakarana or Wittgenstein Island: SE. pass	16 31 00	145 22 45				
	Taiaro or Kings I.: Middle of W. shore	15 43 15	144 38 34				
	Aratika Island: E. pt	15 30 00	145 24 45				
	Toau or Elizabeth Island: Amyot Bay	15 50 00	146 02 45				
	Takapoto Island: S. pt	14 43 00	145 11 00				
	Aheu Island: Lagoon Entrance	14 29 10	146 20 00				
	Rangiroa Island: E. pt	15 14 30	147 11 00	4 30	10 43	2.1	1.3
	Makatea Island: W. pt	15 50 30	148 15 00				
	Matahiva Island: W. pt	14 53 00	148 39 45				

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

ISLANDS OF THE PACIFIC—Continued.

Coast.	Place.	Lat. S.	Long. W.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
	Juan Fernandez Island: Fort S. Juan Batista	33 37 36	78 50 02	....	....	....	.....
	Mas Afuera Island: Summit, 4,000 ft.	33 46 00	80 46 00	....	....	....	.....
	St. Ambrose Island: N. part creek	26 18 07	79 54 56	....	....	....	.....
	St. Felix Island: Center	26 16 00	80 06 56	....	....	....	.....
	Sala y Gomez: NW. pt	26 27 41	105 28 00	4 00	10 15	3.3	2.0
	Easter Island: Cooks Bay, mission	27 10 00	109 26 00	0 40	6 53	2.8	1.7
	Rapa or Oparo Island: Tauna Islet	27 35 46	144 17 20	0 10	6 25	2.4	1.4
	Bass Islets (Morotiri): SE. islet, 344 ft.	27 55 30	143 28 21	....	....	....	.....
	Tubuai or Austral Is., Vavitoa I.: Center.	23 55 00	147 48 00	....	....	....	.....
	Tubuai I.: Flagstaff, N. side	23 21 45	149 35 35	3 00	9 13	2.4	1.4
	Rurutu I.: N. pt.	22 29 00	151 23 41	....	....	....	.....
	Rimitara I.: Center.	22 45 00	152 55 00	....	....	....	.....
Cook Islands.	Hull Island: NW. pt	21 47 00	154 51 00	....	....	....	.....
	Mangaia Island: Center	21 49 00	157 56 00	....	....	....	.....
	Rarotonga Island: NW. pt	21 11 35	159 47 00	6 00	12 15	2.7	1.7
	Mauki or Parry Island: Center	20 17 00	157 23 00	....	....	....	.....
	Mitiero Island: Center	20 01 00	157 34 00	....	....	....	.....
	Vatiu or Atiu Island: Center	20 04 00	158 08 00	....	....	....	.....
	Hervey Islets: Center	19 18 00	158 54 00	....	....	....	.....
	Aitutaki Island: Center	18 54 00	159 32 00	....	....	....	.....
Tonga Is.	Vavau Island: Port Valdes, Sandy Pt.	18 39 02	174 01 00	6 20	0 10	3.8	2.3
	Kao Island: Summit, 5,000 ft.	19 41 35	174 59 50	....	....	....	.....
	Tofua Island: Summit, 2,800 ft.	19 45 00	175 03 00	....	....	....	.....
	Tongatabu Island: Lighthouse	21 08 00	175 12 00	6 20	0 10	3.8	2.3
	Minerva Reefs, N. Minerva: NE. side	23 37 06	178 55 45	7 50	1 35	5.5	3.3
	S. Minerva: S. side of entrance	23 55 00	179 07 45	....	....	....	.....
	Kermadec Is., Raoul or Sunday I.: Denham B. flagstaff	29 15 30	177 55 40	6 00	12 13	3.3	2.7
	Macauley I.: Center	30 15 00	178 31 45	....	....	....	.....
	Curtis I.: Center	30 35 00	178 37 00	....	....	....	.....
			Long. E.				
	Conway Reef: Center	21 44 45	174 37 45	....	....	....	.....
	Loyalty Is., Uvea or Halgan I.: Uvea Church	20 27 06	166 35 25	....	....	....	.....
	Lifu I.: Wreck Bay, NW. shore	20 46 00	167 02 30	6 30	0 18	4.2	2.5
	Mare or Britannia I.: S. pt.	21 42 00	168 00 00	....	....	....	.....
New Caledonia.	Port Kanala: Observatory	21 29 12	165 58 50	....	....	....	.....
	St. Vincent Bay: Marceau I.	22 00 10	166 03 30	5 40	11 52	3.3	2.0
	Noumea: Lighthouse	22 16 22	166 25 52	8 25	2 13	3.1	1.9
	Balari Pass: Amedée I. light	22 28 44	166 28 51	....	....	....	.....
	Port Alcmeme: Alcmene I.	22 42 30	167 27 55	7 55	1 45	3.6	2.2
	Norfolk Island: Inner end of jetty	29 03 45	167 58 06	7 30	1 17	4.7	3.9
	Elizabeth Reef: Center	29 56 00	159 04 30	....	....	....	.....
	Lord Howe Island: S. end of middle beach	31 31 38	159 05 58	8 20	2 08	5.4	3.3
	Balls Pyramid: Summit, 1,816 ft.	31 45 10	159 16 10	....	....	....	.....
	Macquarie Island: N. pt	54 19 00	158 56 00	....	....	....	.....
	Auckland Is.: Port Ross, Terror Cove	50 32 15	166 13 20	11 50	5 38	3.2	2.6
	Campbell Island: S. harbor, Shoal Pt.	52 33 26	169 08 41	11 45	5 33	3.5	2.9
	Antipodes Island: Summit, 600 ft.	49 42 00	178 43 05	3 20	9 30	5.3	4.3
	Bounty Islands: Anchorage N. I., West Group	47 43 00	179 00 27	....	....	....	.....
			Long. W.				
	Chatham Island, Whare-Kauri Island: Port Waitangi, Pt. Hanson	43 57 24	176 32 15	....	....	....	.....
	Chatham Island, Whare-Kauri Island: Port Hutt, Gordon Pt.	43 49 03	176 42 00	5 22	0 23	2.5	2.1

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

AUSTRALIA.

Coast.	Place.	Lat. S.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
North Australia.	Groote Eylandt: SE. pt	14 16 00	136 58 00	.....	.....	.....	.....
	Bickerton Island: Summit	13 45 00	136 15 00	.....	.....	.....	.....
	Cape Arnheim: Extreme	12 14 00	137 00 00	.....	.....	.....	.....
	Cape Wilberforce: E. extreme	11 53 00	136 34 00	8 00	1 48	9.8	5.8
	Cape Wessel: Extreme	10 59 00	136 46 00	.....	.....	.....	.....
	Dale Point: Extreme	11 36 00	136 07 00	.....	.....	.....	.....
	Cape Stewart: Extreme	11 57 00	134 45 00	.....	.....	.....	.....
	Liverpool River: W. pt. entrance	11 54 00	134 12 00	6 17	0 05	12.0	7.1
	Cape Croker: Extreme	10 57 00	132 36 30	.....	.....	.....	.....
	Port Essington: Government house	11 22 02	132 09 18	.....	.....	.....	.....
	Melville Island: Cape Van Diemen	11 08 00	130 19 00	.....	.....	.....	.....
	Bathurst Island: Cape Fourcroy	11 51 00	129 58 00	.....	.....	.....	.....
	Adelaide River: E. entrance pt	12 13 20	131 16 30	5 15	11 27	16.8	9.9
	Port Darwin: Charles Pt. light	12 23 20	130 37 00	4 57	11 18	17.0	10.0
	Port Patterson: Quail Islet	12 30 58	130 27 00	3 50	10 00	16.7	9.9
	Port Keats: Tree Pt	13 59 00	129 37 00	5 45	11 58	21.9	12.9
	Pearce Point: Extreme	14 25 50	129 20 42	6 45	0 27	23.0	13.6
	Victoria River: Water Valley	15 13 45	129 48 14	.....	.....	.....	.....
Western Australia.	Cape Dussejour: Rock off cape	14 42 00	128 10 00	.....	.....	.....	.....
	Cape Londonderry: Extreme	13 44 00	126 57 00	.....	.....	.....	.....
	Cape Bougainville: Extreme	13 52 00	126 12 00	.....	.....	.....	.....
	Cassini Island: S. pt	13 57 07	125 38 45	.....	.....	.....	.....
	Cape Voltaire: Flat Hill	14 15 00	125 39 00	.....	.....	.....	.....
	Barker Islets: Center	13 55 00	124 55 00	.....	.....	.....	.....
	Montalivet Islands: W. islet	14 14 00	125 12 00	.....	.....	.....	.....
	Maret Islets: N. islet	14 23 00	125 00 00	.....	.....	.....	.....
	Colbert Islet: Center	14 51 00	124 42 00	.....	.....	.....	.....
	Prince Regent River: Mount Trafalgar	15 16 36	125 07 00	.....	.....	.....	.....
	Port Nelson: Careening beach	15 06 00	125 01 00	.....	.....	.....	.....
	De Freycinet Islets: Beacon on summit	14 59 20	124 32 11	.....	.....	.....	.....
	Red Islet: Center	15 13 15	124 14 00	.....	.....	.....	.....
	Cockell Islet: W. pt	15 46 00	124 04 00	.....	.....	.....	.....
	MacLeay Islets: Rock off N. end	15 52 00	123 45 00	.....	.....	.....	.....
	Port Usborne: S. pt	15 39 25	123 36 27	.....	.....	.....	.....
	Fitz Roy River: Escape Pt	17 24 25	123 39 47	.....	.....	.....	.....
	Cape L'Evêque: Extreme	16 23 00	122 55 45	.....	.....	.....	.....
	Lacepede Island: NW. islet	16 50 00	122 05 30	.....	.....	.....	.....
	Cape Baskerville: Extreme	17 09 00	122 15 00	.....	.....	.....	.....
	Cape Latouche Tréville: Extreme	18 29 00	121 54 00	.....	.....	.....	.....
	Turtle Isles: Center of N. isle	19 54 00	118 48 00	.....	.....	.....	.....
	Cape Lambert: Extreme	20 36 00	117 11 00	11 30	5 10	17.6	10.4
	Legendre Island: NW. extreme	20 19 00	116 45 00	.....	.....	.....	.....
	Rosemary Island: W. summit	20 27 00	116 30 00	.....	.....	.....	.....
	Enderby Island: Rocky Head	20 35 00	116 23 00	.....	.....	.....	.....
	Montebello Island: N. extreme of reef	20 16 45	115 22 00	.....	.....	.....	.....
	Barrow Island: N. pt	20 40 40	115 27 45	.....	.....	.....	.....
	Northwest Cape: Extreme	21 46 41	114 10 08	.....	.....	.....	.....
	Cape Cuvier: Extreme	24 00 00	113 21 00	.....	.....	.....	.....
	Cape Inscription: Extreme	25 29 19	112 57 09	.....	.....	.....	.....
	Houtman Rocks: N. islet	28 18 05	113 35 33	.....	.....	.....	.....
	Port Gregory	28 12 00	114 14 30	.....	.....	.....	.....
	Cape Leschenault: Extreme	31 18 00	115 30 00	.....	.....	.....	.....
	Rottnest Island: Lighthouse	32 00 20	115 30 12	.....	.....	.....	.....
	Perth (Fremantle): Arthur Head light	32 03 12	115 43 48	[10 16]	[3 43]	[2.1]	.....
	State Observatory	31 57 09	115 50 26	.....	.....	.....	.....
	Peel: Robert Pt	32 27 00	115 44 00	.....	.....	.....	.....
	Cape Naturaliste: Extreme	33 31 45	115 00 15	.....	.....	.....	.....
	Cape Leeuwin: Lighthouse	34 21 55	115 08 00	.....	.....	.....	.....
	D'Entrecasteaux Point: Extreme	34 52 00	116 01 00	.....	.....	.....	.....
	Nuyts Point: Extreme	35 05 00	116 38 00	.....	.....	.....	.....
	West Cape Howe: Extreme	35 09 00	117 40 00	.....	.....	.....	.....
	Eclipse Islets: Summit of largest	35 11 54	117 53 45	.....	.....	.....	.....
	King George Sound: Commissariat house near Albany jetty	35 02 20	117 54 04	[10 53]	[4 40]	[2.6]	.....

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

AUSTRALIA—Continued.

Coast.	Place.	Lat. S.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Western Australia.	Bald Isle: Center	34 55 00	118 27 00				
	Hood Point: Doubtful Isles	34 24 00	119 34 00				
	Recherche Archipelago: Termination Isle	34 30 00	121 58 00				
	Culver Point: Extreme	32 57 00	124 39 00				
	Dover Point: Extreme	32 34 00	125 30 00				
South Australia.	Fowler Point: Extreme	32 01 30	132 33 00	11 50	9 35	5.1	0.3
	Streaker Bay: Port Blanche	32 48 00	134 13 40				
	Coffin Bay: Mount Dutton	34 29 29	135 24 56	0 35	6 55	5.5	0.3
	Cape Catastrophe: W. pt.	35 00 15	135 56 09				
	Neptune Isles: SE. islet	35 20 15	136 06 24				
	Port Lincoln: English Church	34 43 22	135 51 03				
	Franklin Harbor: Observation spot	33 44 08	136 57 22				
	Port Augusta: Flagstaff	32 29 42	137 45 24	8 20	2 15	11.4	0.7
	Port Victoria: Wardang Island hut	34 28 25	137 22 21				
	Cape Spencer: S. pt.	35 18 21	136 53 30				
	Investigator Strait: Troubridge light	35 07 31	137 49 39				
	Port Wakefield: Lighthouse	34 12 00	138 09 00	4 31	10 45	10.2	0.6
	Port Adelaide: Wonga Shoal light	34 50 25	138 26 58	4 04	10 22	6.3	0.9
	Observatory	34 55 38	138 35 05				
	Cape Jervis: Lighthouse	35 36 45	138 05 29				
	Cape Borda: Lighthouse	35 45 30	136 34 39				
	Cape Willoughby: Lighthouse	35 51 00	138 07 45	4 00	10 15	5.8	0.3
	Port Victor: Flagstaff	35 34 06	138 37 09				
	Cape Jaffa: Margaret Brock lighthouse	36 57 00	139 39 39				
	Cape Northumberland: Lighthouse	38 04 18	140 39 40	11 52	5 40	4.2	0.2
Victoria.	Cape Nelson: S. extreme	38 26 00	141 32 39				
	Portland Bay: Lawrence Rock	38 24 39	141 40 02	0 20	6 35	2.7	2.1
	Port Fairy: Griffith Island summit	38 23 47	142 14 37				
	Cape Otway: Lighthouse	38 51 45	143 30 39				
	King Island: Cape Wickham light	39 35 38	143 57 03				
	Port Phillip: Point Lonsdale light	38 18 00	144 37 00	10 43	4 30	2.5	1.9
	Geelong: Customhouse	38 08 52	144 21 47	2 02	8 20	3.0	2.3
	Melbourne: Observatory	37 49 53	144 58 35	2 19	8 41	1.9	1.5
	Cape Schanck: Lighthouse	38 29 42	144 52 51				
	Port Western: Extreme of W. head	38 29 15	145 01 34				
	Wilson Promontory: Light, SE. pt.	39 08 00	146 25 16				
	Kent Island: Deal Island light	39 25 45	147 18 39				
	Flinders Is.: Strzelecki Peaks, SE. peak	40 11 45	148 04 00				
	Goose Island: Light on S. end	40 18 40	147 47 39	10 38	4 25	8.1	6.2
	Banks Strait: Swan Island light	40 43 40	148 07 24				
	Port Albert: Lighthouse	38 45 06	146 37 43				
	Gabo Island: Lighthouse	37 34 15	149 55 10	8 40	2 27	4.5	3.4
	Cape Howe: East extreme	37 30 10	149 58 39				
New South Wales.	Cape Green: SE. pt.	37 15 40	150 03 04				
	Twofold Bay: Lookout Pt. light	37 04 18	149 54 45	8 05	1 52	5.2	3.1
	Dromedary Mountain: Summit	36 18 30	150 01 34				
	Montagu Island: Lighthouse	36 14 30	150 13 34	8 20	2 07	5.3	3.2
	Bateman Bay: Observation head	35 43 58	150 12 34				
	Ulladulla: Inner end of pier	35 21 41	150 29 29	8 20	2 07	5.4	3.3
	Jervis Bay: Lighthouse	35 09 15	150 46 26				
	Kiama Harbor: Outer extreme of S. head	34 40 25	150 52 19				
	Wollongong: Summit of head	34 25 30	150 55 14				
	Sydney: Observatory	33 51 41	151 12 23	8 40	2 27	4.2	2.5
	Port Jackson: Outer S. Head light	33 51 30	151 18 15				
	Broken Bay: Baranjo Head light	33 35 00	151 20 30				
	Newcastle: Nobby Head light	32 55 15	151 48 19	8 35	2 23	4.7	2.8
	Port Stephens: Lighthouse	32 45 10	152 13 20	8 15	2 00	5.8	3.6
	Sugar Loaf Point: Lighthouse	32 26 20	152 33 40				
	Port Macquarie: Entrance	31 25 30	152 55 19	9 00	2 46	4.1	2.4
	Solitary Islands: S. Isle light	30 12 00	153 17 00				
	Clarence River: S. Head light	29 25 30	153 23 10	8 15	2 00	4.0	2.4

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

AUSTRALIA—Continued.

Coast.	Place.	Lat. S.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
Queensland.	Richmond River: N. Head light	28 51 30	153 35 55				
	Brisbane: Signal station, Fisherman Is.	27 23 22	153 10 31	10 45	4 30	6.4	3.9
	Observatory	27 28 00	153 01 36				
	Lookout Point: Extreme	27 26 20	153 33 50				
	Cape Moreton: Lighthouse	27 02 10	153 28 04				
	Double Island Point: Lighthouse	25 56 00	153 13 00				
	Indian Head: Extreme	25 00 15	153 23 00				
	Sandy Cape: Lighthouse	24 43 20	153 13 40				
	Burnett River: S. Head light	24 45 00	152 25 00				
	Lady Elliot Islet: Lighthouse	24 07 00	152 45 15				
	Bustard Head: Lighthouse	24 01 20	151 41 04				
	Rodd Bay: Spit end	24 01 20	151 37 15				
	Port Curtis: Gatcombe Head light	23 53 00	151 23 50				
	Cape Capricorn: Lighthouse	23 29 30	151 14 04				
	Port Bowen: Observation rock	22 31 40	150 45 44				
	Percy Isles: Pine I. light	21 39 00	150 14 00				
	Northumberland Isles: Summit of Prudhoe I.	21 19 15	149 43 30				
	Cape Palmerston: N. extreme	21 32 00	149 31 04				
	Cape Conway: SE. pt	20 32 20	148 58 00				
	Port Molle: S. side of entrance	20 18 50	148 53 15				
	Cumberland Island: Whitsunday I., summit on W. side	20 15 30	149 00 00				
	Port Denison: Obs. pt., W. side of Stone Isle	20 00 50	148 16 54	10 05	3 53	9.0	5.4
	Gloucester Island: Summit near N. end	19 57 30	148 27 34				
	Holborne Islet: Center	19 41 50	148 23 00				
	Cape Bowling Green: Lighthouse	19 19 20	147 27 40				
	Cape Cleveland: Lighthouse	19 11 25	147 01 10				
	Palm Islands: SE. point of SE. island	18 45 30	146 42 50				
	Rockingham Bay: Peak of Goold Isle	18 09 30	146 11 04				
	Barnard Island: Lighthouse	17 40 40	146 11 00				
	Frankland Island: High islet	17 09 45	146 02 30				
	Cape Tribulation: Extreme	16 04 20	145 29 34				
	Hope Island: S. islet	15 45 00	145 28 30				
	Cook Mountain: Summit	15 29 45	145 17 30	8 55	2 43	7.5	4.5
	Cape Bedford: SE. extreme	15 16 30	145 23 15				
	Murdock Point: Extreme	14 37 15	144 57 30				
	Cape Melville: NE. extreme	14 10 00	144 32 34				
	Flinders Island: N. extreme of N. island	14 07 45	144 15 19				
	Claremont Point: Extreme	14 00 30	143 42 15				
	Cape Sidmouth: Extreme	13 24 45	143 36 19	9 00	2 47	9.6	5.8
	Cape Direction: NE. extreme	12 51 00	143 34 00				
	Cape Grenville: Extreme	11 58 15	143 15 15				
	Sir Charles Hardy Island: N. extreme of SE. isle	11 55 00	143 29 00				
	Bird Island: NW. isle	11 46 30	143 06 00				
	Hannibal Isles: E. isle	11 36 30	142 56 19				
	Cape York: Sextant Rock	10 41 30	142 32 24	1 00	7 10	8.0	4.7
	Mount Adolphus: Summit	10 37 45	142 39 20				
	Travers Isles: Center	10 22 00	142 21 19				
	Prince of Wales Island: Cape Cornwall, extreme	10 46 00	142 10 50				
	Booby Island: Center	10 36 05	141 53 49	4 20	10 30	7.8	4.7
	Flinders River: Entrance	17 36 40	140 37 06				
	Albert River: Kangaroo Pt	17 35 10	139 45 56				
	Sweers Island: Inscription Pt	17 06 50	139 38 36				

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

TASMANIA.

Coast.	Place.	Lat. S.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
	Cape Portland: NW. pt	40 44 15	147 56 09				
	Port Dalrymple: Low Head light	41 03 25	146 47 54	11 10	5 00	9.0	6.9
	Port Sorrell: NW. entrance head	41 07 05	146 33 30				
	Port Frederick: Entrance	41 10 00	146 24 30				
	Leven River: W. entrance head	41 08 30	146 12 00				
	Emu Bay: Blackman Pt	41 02 50	145 56 39				
	Hunter Island: N. pt	40 23 40	144 47 45				
	Cape Grim: Outer Doughboy Islet	40 40 10	144 39 44				
	Albatross Islet: N. pt	40 22 00	144 39 19				
	Arthur River: Entrance	41 04 00	144 44 00				
	Pieman River: Rocks close to entrance	41 41 00	144 57 00				
	Macquarie Harbor: Entrance Islet	42 11 37	145 12 34	7 20	1 07	2.7	2.1
	Cape Sorrell: Lighthouse	42 11 00	145 10 30				
	Port Davey: Pollard Head	43 19 00	145 53 00				
	Southwest Cape: Extreme pt	43 33 30	146 01 04				
	Mewstone Rock: Center	43 44 30	146 22 04				
	Cape Bruny: Lighthouse	43 29 40	147 08 49				
	Bruny Island: Penguin Islet	43 21 00	147 23 40				
	Hobart Town: Transit of Venus station	42 53 25	147 20 07	8 05	1 52	4.2	3.2
	Cape Pillar: Tasman Islet	43 14 00	148 02 00				
	Cape Frederik Hendrik: Extreme	42 52 00	148 00 00				
	Freycinet Peninsula: Summit	42 13 00	148 18 04				
	St. Patrick Head: N. pt	41 34 00	148 19 30				
	Eddystone Point: Extreme	40 59 40	148 20 50				

NEW ZEALAND.

Coast.	Place.	Lat. S.	Long. E.	H. W.	L. W.	Spg.	Neap.
North Island.	Three Kings Islands: NE. extreme of NE. island	34 06 20	172 08 49				
	North Cape: Cape Islet	34 25 07	173 03 34				
	Parenga-renga Harbor: Kohan Pt	34 31 00	173 00 54				
	Maunganui Harbor: White Pt	35 00 20	173 32 39				
	Wangaroa Harbor: Peach Islet	35 01 44	173 45 48	7 40	1 30	6.4	4.5
	Bay of Islands: Motu Mea Islet	35 17 00	174 06 06	7 26	1 55	5.9	4.2
	Wangaruru Harbor: Grove Pt	35 23 48	174 21 24	7 15	1 05	6.5	4.6
	Wangari Harbor: Loot Pt	35 51 09	174 31 14	7 05	0 55	6.7	4.8
	Great Barrier Island: Needles Pt	36 01 15	175 25 34				
	Auckland Harbor: Lighthouse	36 50 06	174 51 00	7 20	1 10	10.8	7.7
	Coromandel Harbor: Tuhnia I	36 48 35	175 24 34	7 05	0 55	10.7	7.6
	Cape Colville: N. pt	36 28 20	175 21 04				
	Cuvier Island: Lighthouse	36 26 20	175 49 00				
	Tauranga Harbor: Mount Maunganui, 860 ft	37 36 25	176 10 14	7 05	0 55	6.1	4.4
	White Island: Summit, 863 ft	37 30 00	177 10 49				
	Cape Runaway: Extreme	37 30 45	177 59 34	8 10	2 00	6.6	4.7
	East Cape: Islet, 420 ft	37 40 00	178 35 09	8 00	1 50	6.8	5.8
	Tolaga Bay: Matu-heka Islet	38 20 50	178 20 14				
	Mahia Peninsula: S. extreme of Portland I	39 18 00	177 53 15				
	Ahuriri Harbor: Lighthouse	39 28 30	176 54 14	6 05	12 15	3.5	3.0
	Kidnappers Cape: Extreme	39 38 00	177 06 44				
	Cape Palliser: Lighthouse	41 36 45	175 18 45	4 40	10 50	5.7	4.9
	Port Nicholson: Pencarrow light	41 21 40	174 51 04				
	Wellington: Queens Wharf light	41 17 17	174 47 25	4 52	10 54	3.6	3.1
	New Observatory	41 17 04	174 46 04				
	Mana-watu River: Lighthouse	40 27 10	175 14 40	9 40	3 30	6.3	5.4
	Wanganui River: N. head	39 57 00	174 59 44				
	Egmont Mountain: Summit, 8,270 ft	39 18 00	174 03 59				
	New Plymouth: Flagstaff	39 03 35	174 04 35	9 15	3 05	11.6	8.2
	Kawhia Harbor: S. head	38 04 50	174 48 04	9 10	3 00	11.9	8.5

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

NEW ZEALAND—Continued.

Coast.	Place.	Lat. S.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
North Island.	Aotea Harbor: S. head	37 59 35	174 50 04	......	......	......	.....
	Whaingaroa Harbor: S. entrance pt	37 46 22	174 52 19	9 08	2 55	12.3	8.7
	Manukau Harbor: Paratutai flagstaff	37 03 00	174 31 14	9 05	2 50	12.6	9.0
	Kaipara Harbor: Lighthouse	36 23 00	174 08 00	9 00	2 50	10.0	7.1
	Hokianga River: Flagstaff at entrance	35 32 05	173 21 59	8 40	2 30	9.2	6.5
South Island.	Cape Campbell: Lighthouse	41 44 00	174 17 14	4 45	11 00	7.5	6.5
	Port Cooper: Lyttleton customhouse	43 46 40	172 44 17	3 45	10 00	7.4	5.8
	Akaroa Island: Lighthouse	43 54 00	173 00 20	......	......	......	.....
	Ashburton River: N. entrance pt	44 04 50	171 48 34	......	......	......	.....
	Waitangi River: N. entrance head	44 54 50	171 11 14	......	......	......	.....
	Otago Harbor: Taivoa Head light	45 46 55	170 44 02	3 31	9 39	5.6	4.4
	Molyneux Bay: Landing place	46 24 05	169 47 53	......	......	......	.....
	Nugget Point: Lighthouse	46 27 10	169 50 04	......	......	......	.....
	Bluff Harbor: Lighthouse	46 37 00	168 23 00	1 05	7 15	7.8	6.2
	Tewaewae Bay: Pahia Pt	46 20 40	167 42 19	......	......	......	.....
	Solander Islands: Summit, 1,100 ft	46 36 00	166 54 04	......	......	......	.....
	Preservation Inlet: Lighthouse	46 10 00	166 38 15	11 10	5 00	7.5	5.9
	West Cape: Extreme	45 54 50	166 25 49	......	......	......	.....
	Queenstown: U. S. Tr. of Venus station	45 02 07	168 40 06	......	......	......	.....
	Milford Sound: Freshwater Basin	44 40 20	167 54 45	......	......	......	.....
	Cascade Point: N. extreme	44 00 30	168 21 34	......	......	......	.....
	Grey River: Entrance	42 26 20	171 11 54	10 10	4 00	9.8	7.7
	Hokitika: Entrance light	42 42 20	170 59 30	10 20	4 10	9.5	7.5
	Cape Foulwind: Lighthouse	41 45 40	171 27 44	......	......	......	.....
	Cape Farewell: Extreme	40 29 50	172 41 04	......	......	......	.....
	Nelson: Bowlder Bank light	41 16 05	173 17 30	9 55	3 45	12.0	9.4
	D'Urville Island: Port Hardy	40 46 35	173 54 04	9 45	3 35	11.6	9.2
	Port Gore: Head of Melville Cove	41 01 55	174 11 22	......	......	......	.....
	Port Underwood: Flag Pt	41 20 28	174 08 24	6 00	12 15	7.6	6.6
Stewart I.	Port William: Howell's house	46 50 30	168 05 34	......	......	......	.....
	Paterson Inlet: Glory Cove	46 58 30	168 09 54	1 00	9 15	7.8	6.2
	Port Adventure: White Beach, S. end	47 03 52	168 10 57	......	......	......	.....
	Port Pegasus: Cove abreast Anchorage I	47 11 40	167 40 51	11 45	5 40	7.9	6.2
	Codfish Island: NW. extreme	46 45 45	167 36 49	......	......	......	.....
	Snares Islands: SW. islet	48 06 43	166 27 44	......	......	......	.....

THE ARCTIC REGIONS.

	Place.	Lat. N.	Long. W.	H. W.	L. W.	Spg.	Neap.
	Cape Walsingham: Extreme	66 00 00	69 28 00	......	......	......	.....
	Mile Island: N. pt	64 04 00	77 50 00	......	......	......	.....
	Marble Island: E. end	62 33 00	91 06 00	4 00	10 15	12.0	5.1
	Cape Kendall: Extreme	63 42 00	87 15 00	......	......	......	.....
	Iglooik Island: E. pt	69 21 00	81 31 00	6 50	0 40	8.0	4.2
	Victoria Harbor: N. shore	70 09 17	91 30 33	......	......	......	.....
	Elizabeth Harbor: Entrance	70 38 14	92 10 56	......	......	......	.....
	Magnetic Pole, 1831	70 05 00	96 47 00	......	......	......	.....
	Port Neill: N. pt. of entrance	73 09 13	89 00 54	......	......	......	.....
	Port Bowen: N. cove	73 13 39	88 54 48	......	......	......	.....
	Batty Bay: S. pt. of entrance	73 13 00	91 08 00	......	......	......	.....
	Port Leopold: Whaler Pt	73 50 05	90 12 00	11 38	5 29	5.5	2.9
	Careys Islands	76 49 00	73 10 00	......	......	......	.....
	Discovery Harbor	81 04 40	64 45 00	......	......	......	.....
	Alert's Winter Quarters	82 27 00	61 18 00	10 35	4 20	2.6	1.0
	Cape Joseph Henry: N. extreme	82 40 00	63 38 00	......	......	......	.....
	Cape Hecla: N. extreme	82 54 00	64 45 00	......	......	......	.....
	Cape Columbia: Extreme	83 07 00	70 20 00	......	......	......	.....
	Melville Island: Winter Harbor	74 47 10	110 48 15	1 20	7 40	3.8	1.9
			Long. E.				
	North Cape	68 55 00	179 57 00	......	......	......	.....

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

THE ARCTIC REGIONS—Continued.

Coast.	Place.	Lat. N.	Long. E.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
	Liakhov Islands: E. pt. of New Siberia	75 10 00	150 30 00				
	Cape Tscheljuskin: E. pt	77 41 00	104 01 00				
	Nova Zembla: Vaigats I., N. pt	70 25 00	59 10 00				
	Cape Costin (Kostina)	70 55 00	53 01 50	10 00	3 50	7.0	4.0
	NE. pt., Cape Desire	76 58 00	65 40 00				
	Franz Josef Land: Wilczek I	79 55 00	58 45 00				
	Mezen: Epiphany Church	65 50 18	44 17 00				
	Morjovetz Island: Lighthouse	66 45 50	42 30 00				
	Archangel: Trinity Church	64 32 06	40 33 30	7 18	2 00	2.2	1.3
	Jighinsk Island: Lighthouse	65 12 17	36 51 30	5 05	11 30	3.8	2.1
	Onega: St. Michael's Church	63 53 36	38 08 30	9 02	3 10	9.1	5.2
	Salovetski: Lighthouse	65 07 00	35 37 00				
	Cape Sviatoi Nos: Lighthouse	68 08 51	39 48 54	9 05	2 55	13.9	7.8
	Bear Island	74 30 00	20 00 00				
	Spitzbergen Island: S. cape	76 35 00	17 23 00				
	Cloven Cliff	79 50 00	11 40 30				
	Danes I., Robbe Bay	79 42 00	11 07 00	0 14	6 25	5.3	3.0
		Lat. N.	Long. W.				
Greenland.	Cape Morris Jesup	83 39 00	30 40 00	(approx)			
	Thank God Harbor	81 38 00	61 44 00	12 14	5 58	5.4	2.0
	Cape York: Extreme	75 55 00	65 30 00				
	Upernivik: Flagstaff	72 47 48	55 53 42	10 50	4 38	8.0	3.0
	Proven: Village	72 20 42	55 20 00				
	Omenak Island: Village	70 40 00	51 59 00				
	Godhavn: Village	69 14 04	53 24 07				
	Jacobshavn: Village	69 13 12	50 56 30				
	Claushavn: Village	69 07 30	50 55 30				
	Christianshaab: Village	68 49 06	51 00 00				
	Egedesmunde: Village	68 42 30	52 46 00				
	Whalefish Island: Boat Inlet	68 58 30	53 27 00	8 05	1 52	7.5	3.6
	Holsteinberg: Village	66 55 54	53 40 18	6 20	0 07	10.0	4.8
	Kangamint	65 48 42	53 23 00				
	Ny Sukkertop: Village	65 24 30	52 54 00				
	Godthaab: Flagstaff	64 10 36	51 45 48	6 40	0 27	12.5	6.0
	Sermelik Fjord: Kasuk Peak	63 29 12	51 10 48				
	Fiskernaes: Village	63 05 12	50 43 36				
	Jensen Nunatak: Peak	62 50 00	48 57 00				
	Ravn Storo: Peak	62 42 36	50 20 48				
	Frederikshaab: Church	61 59 36	49 44 00	6 12	0 00	9.0	3.6
	Kangarssuk Havn: Village	61 28 20	48 51 00				
	Arsuk: Pingo Beacon	61 10 24	48 26 00	6 15	0 03	12.0	4.8
	Kajartalik Island: Summit	61 09 42	48 30 42				
	Ivigtuk: House	61 12 12	48 10 30				
	Bangs Havn: Anchorage	60 47 30	47 52 00				
	Aurora Harbor	60 48 36	47 46 48				
	Julianshaab: Village	60 43 07	46 01 00	4 56	11 09	7.0	2.8
	Neunortalik: Village	60 08 12	45 16 00	5 33	11 46	8.6	3.4
	Frederiksthal: Village	60 00 00	44 40 00	2 55	9 10	9.4	3.8
	Cape Farewell: Staten Huk	59 49 00	44 01 42	4 00	10 13	7.5	3.0
	Aleuk Islands: Center	60 09 00	42 55 00				
	Cape Tordenskjold: Extreme	61 25 00	42 15 00				
	Cape Bille: Extreme	62 01 00	42 00 00				
	Cape Juul: Extreme	63 14 00	40 50 00				
	Cape Lowenorn: Extreme	64 30 00	39 30 00				
	Dannesbrog Island: Beacon	65 18 00	38 30 00				
	Ingolsfjeld	66 19 02	35 11 00				
	Rigny Mount: Summit	69 00 12	26 10 24				
	Pendulum Islands	74 40 00	18 17 00	11 05	4 53	6.7	3.9
	Cape Philipp Broke	74 55 00	17 33 00	11 10	4 58	3.7	2.1
	Cape Bismarck: Extreme	76 47 00	18 40 00				

APPENDIX IV.

MARITIME POSITIONS AND TIDAL DATA.

THE ARCTIC REGIONS—Continued.

Coast.	Place.	Lat. N.	Long. W.	Lun. Int.		Range.	
				H. W.	L. W.	Spg.	Neap.
		° ′ ″	° ′ ″	h. m.	h. m.	ft.	ft.
	Jan Mayen Island: Mt. Beerenberg, 6,870 ft	71 04 00	7 36 00	....	....	......	.....
	Youngs Foreland, or Cape Northeast	71 08 00	7 26 00	....	....	......	.....
	Mary Muss Bay	71 00 00	8 28 00	11 21	5 06	3.8	2.2
Iceland.	Langanaes Point	66 22 45	14 30 46	....	....	......	.....
	Rissnaes Point	66 32 40	16 10 24	....	....	......	.....
	Grimsey Norddranger: Tr. Station	66 33 42	17 57 36	....	....	......	.....
	Skagataas Point	66 07 30	20 05 26	....	....	......	.....
	North Cape: Kalfatindr	66 27 29	22 23 04	....	....	......	.....
	Straumness Point	66 26 30	23 08 00	....	....	......	.....
	Fugle or Staabierg Huk: Point	65 30 15	24 31 26	....	....	......	.....
	Snaefells Yokul: Tr. Station	64 48 04	23 45 08	....	....	......	.....
	Reykiavik: Observatory	64 08 40	21 55 00	5 10	11 25	14.5	8.4
	Cape Skagi: Lighthouse	64 04 09	22 39 04	....	....	......	.....
	Reykianaes: Lighthouse	63 48 06	22 39 00	....	....	......	.....
	Ingolfshofde: Tr. Station	63 48 19	16 36 13	....	....	......	.....
	Papey Island: Tr. Station	64 35 42	14 08 31	....	....	......	.....
	Reythur Fjeld: Tr. Station	64 55 27	13 41 10	....	....	......	.....
	Balatangi: Lighthouse	65 16 14	13 32 22	....	....	......	.....
	Dia Fjeld: Tr. Station	65 45 00	14 23 35	....	....	......	.....

INDEX TO APPENDIX IV.

REGIONS AND COASTS.

Page.
Admiralty Islands.......... 346
Adriatic Sea.......... 315–321
Africa, east coast...... 323–325
—— north coast...... 320, 321
—— west coast........ 321–323
Alabama.................. 284
Alaska............... 287, 288
Albania.................. 318
Aleutian Islands........... 287
Algeria.................. 321
Arabia.................. 327
Arctic regions......... 355–357
Argentina................ 298
Asia, east coast........ 331–342
—— —— —— islands..... 332
—— south coast....... 327–330
Atlantic Ocean, islands 302–304
Australia............ 351–353
Austria.............. 317, 318
Azores Islands............ 302

Bahama Islands.......... 292
Balearic Islands........... 316
Baluchistan.............. 328
Banka Strait............. 331
Belgium................ 313
Belize............... 285, 286
Bermuda Islands......... 303
Black Sea........... 315–321
Borneo.................. 333
Brazil............... 295, 297
British Columbia...... 288, 289
Burma.................. 329

California............... 289
Canary Islands........... 303
Cape Breton Island....... 281
—— Verde Islands........ 303
Caroline Islands.......... 343
Celebes Island........... 333
Central America, east coast............. 285–287
—— —— west coast........ 291
Ceylon.................. 329
Chile.............. 298–301
China.............. 337, 338
—— Sea................ 337
—— —— Entrance....... 331
Chosen.................. 339
Cochin China............ 336
Colombia, north coast.. 295, 302
—— west coast............
Connecticut.......... 282, 283
Cook Islands............ 350
Coral Sea Archipelago...... 347
Corsica................. 316
Costa Rica............... 286
Crozet Islands........... 327
Cuba............... 292, 293
Cyprus.................. 320

Delaware................ 283
Denmark................ 312

Page.
East Indian Is., smaller Dutch.................. 332
Ecuador................. 302
Egypt.................. 320
Ellice Islands............ 345
Europe, Atlantic coast. 304–315

Falkland Islands.......... 304
Fiji Islands.......... 347, 348
Florida................. 284
Formosa Island.......... 338
France, north and west coasts............ 313, 314
France, south coast........ 316

Galapagos Islands......... 342
Gaspar Strait............ 331
Georgia................. 283
Germany............ 310–312
Gilbert Islands........... 342
Great Britain.......... 304–307
Greece.................. 319
Greenland............... 356
Guatemala............... 286
Guiana................. 296

Haiti, island of........ 293, 294
Hawaiian Islands......... 344
Holland................. 313
Honduras............... 286

Iceland................. 357
India.............. 328, 329
Indian Ocean, islands.. 325–327
Italy............... 316, 317

Jamaica................ 293
Japan.............. 339–341
Java................... 331

Kerguelen Islands......... 327
Korea.................. 339
Kuril Islands............ 341

Labrador............ 279, 280
Laccadive Islands......... 325
Ladrone Islands.......... 344
Louisiade Archipelago..... 347
Louisiana............... 284
Lower California.......... 290

Madagascar.............. 326
Madeira Islands.......... 303
Magdalen Islands......... 280
Maine.............. 281, 282
Malaysia........... 329, 330
Maldive Islands.......... 325
Mariana Islands.......... 344
Marquesas Islands........ 345
Marshall Islands......... 343
Maryland............... 283
Massachusetts........... 282
Mauritius Island.......... 325

Page.
Mediterranean Sea.... 315–321
Mexico, east coast......... 285
—— west coast........ 290, 291
Mississippi............... 284
Molukka Islands...... 332, 333
Morocco................ 321
Mosquito Coast........... 286

New Brunswick...... 280, 281
—— Caledonia........... 350
Newfoundland........ 279, 280
New Guinea Island....... 346
—— Hampshire.......... 282
—— Hebrides Islands...... 347
—— Jersey.............. 283
—— South Wales......... 352
—— York............ 282, 283
—— Zealand.......... 354, 355
Nicaragua............... 286
North America, east coast 279–287
—— —— west coast.... 287–291
—— Australia............ 351
—— Carolina............ 283
—— Island, New Zealand 354, 355
Norway............. 307, 308
Nova Scotia.............. 281

Oregon.................. 289

Pacific Ocean, islands.. 342–350
Panama................. 287
Pelew Islands............ 344
Pennsylvania............. 283
Persia.................. 328
Peru............... 301, 302
Philippine Islands.... 333–336
Phœnix Islands........... 345
Porto Rico............... 294
Portugal............ 314, 315
Prince Edward Island...... 280

Queen Charlotte Islands.... 288
Queensland.............. 353

Red Sea............. 324, 325
Rhode Island............. 282
Russia, south coast........ 320
—— west coast........ 309, 310

St. Lawrence, River and Gulf................... 280
Samoan Islands........... 348
Santa Cruz Islands........ 347
Sardinia................ 316
Siam, Gulf.............. 336
Siberia............. 341, 342
Society Islands........... 349
Solomon Islands.......... 346
South America, north and east coasts.......... 295–298
South America, W. coast 298–302
—— Australia............ 352
—— Carolina............ 283

REGIONS AND COASTS—continued.

Page.
South Island, New Zealand ... 355
S. W. Is. of Japan ... 338, 339
Spain, north and west coasts ... 314, 315
—— south and east coasts ... 315
Stewart Island ... 355
Sumatra ... 330
Sweden ... 308, 300

Taiwan (Formosa) ... 338

Page.
Tasmania ... 354
Texas ... 284
Tokara Islands ... 339
Tonga Islands ... 350
Trinidad ... 296
Tuamotu Archipelago ... 349
Tunis ... 321
Turkey ... 320

Uruguay ... 298

Page.
Vancouver Island ... 288
Venezuela ... 295, 296
Victoria ... 352
Virginia ... 283

Washington ... 289
Western Australia ... 351, 352
West India Islands ... 292–295

Yucatan ... 285

PLACES.

Aalborg ... 312
Aarhus ... 312
Ababa Island ... 347
Abaco Island ... 292
Abang Besar Island ... 330
Abbeville ... 313
Abd-al-Kuri Island ... 324
Aberdeen ... 305
Abervrach ... 313
Aberystwith ... 304
Abingdon Island ... 342
Abo ... 309
Aboukir Bay ... 320
Abreojos Point ... 290
Abrolhos Island ... 297
Absecon Inlet ... 283
Acajutla ... 291
Acapulco ... 291
Accra ... 322
Acheen Head ... 330
Aconcagua Mountain ... 300
Acre ... 320
Adakh Island ... 287
Adalia ... 320
Adams, Port ... 338
Addu Atoll ... 325
Adelaide, Port ... 352
—— River ... 351
Adéle Island ... 347
Aden ... 327
Adenara Island ... 332
Admiralty Head ... 289
—— Islands ... 346
Adolphus Mountain ... 353
Adventure, Port ... 355
Ægina ... 319
Aero Island ... 312
Ærstenen ... 308
Africa Rock ... 316
Agalegas Island ... 326
Agdenes ... 307
Agiabampo ... 291
Agrigan Island ... 344
Aguadilla Bay ... 294
Aguja Point ... 302
Agulhas, Cape ... 323
Agutaya Islet ... 334
Aheu Island ... 349
Ahunui Island ... 349
Ahuriri ... 354
Ai Sima ... 341
Aian ... 341
Aignan, St., Island ... 347
Aigues Mortes ... 316
Ailinginae Islands ... 343
Aillick Harbor ... 279
Ailly Point ... 313
Ailuk Islands ... 343
Aitutaki Island ... 350
Aix Island ... 314
Ajaccio ... 316
Ajano ... 320
Akamokan Island ... 344
Akaroa Island ... 355
Akashi-no-seto ... 340
Akpatok Island ... 279
Akyab ... 329
Alacran Reef ... 285
Alamaguan Island ... 344
Aland Island ... 309
Alargate Reef ... 286
Albany ... 283
Albatross Islet ... 354
Albemarle Island ... 342
Albert, Port ... 352
—— River ... 353
Alboran Island ... 321
Albuquerque Bank ... 286
Alcatrazes Island ... 297
Alcmene ... 350
Alcobaça ... 297
Aldabra Island ... 327
Alden ... 308
Alderney Harbor ... 307
Alegranza Island ... 303
Alegre, Porto ... 297
Alert's Winter Quarters ... 355
Alessandro, San, Island ... 345
Aleuk Islands ... 356
Alexander, Port ... 322
—— —— Vancouver ... 288
Alexandretta ... 320
Alexandria ... 320
Alfaques, Port ... 315
Alfred, Port ... 323
Algeciras ... 315
Algiers ... 321
Ali-Agha, Port ... 320
Alicante ... 315
Alijos Rocks ... 290
Alipee ... 328
Alligator Island ... 337
—— Reef ... 284
Almadie Point ... 321
Almeria ... 315
Almirante Bay ... 287
Alphonse Island ... 325
Alta Vela ... 294
Altata ... 291
Altea ... 315
Altona ... 311
Alvarado ... 285
Amager Island ... 312
Amber, Cape ... 326
Amboina Island ... 332
Ambrose, St., Island ... 350
Amchitka Island ... 287
Amelia Island ... 284
Ameni Islet ... 325
Amherst Harbor ... 280
Amirante Islands ... 325
Amour Point ... 280
Amoy ... 337
Amsterdam ... 313
—— Island ... 327
Ana, Sta., Lagoon ... 285
Anaa Island ... 349
Anacapa Island ... 289
Anadir River ... 342
Analaboe ... 330
Anamba Islands ... 331
Anataxan Island ... 344
Anchorite Island ... 346
Ancona ... 317
Ancud ... 300
Andaman Islands ... 329
Andenes ... 307
Andrava Bay ... 326
Andrea, St., Rock ... 318
Andrew, St ... 281
—— —— Cape ... 326
—— —— Island ... 346
Andrews, St., Island ... 286
Andros Island, Bahamas ... 292
—— —— Grecian Arch ... 319
Anegada ... 294
Aneityum Island ... 347
Angatau ... 349
Angaur Island ... 344
Angeles Bay ... 290
—— Los ... 289
—— Port, Mexico ... 291
—— ——, Washington ... 289
Anghris Head ... 306
Angosto, Port ... 299
Angoxa Island ... 323
Angra dos Reis ... 297
—— Pequena ... 322
Anguilla ... 294
Anhatomirim ... 297
Anholt Island ... 312
Animas, Las ... 290
Anjer ... 331
Anjoe, Cape ... 331
Ann, Cape ... 282
—— St., Bay ... 293
Anna, Sta., Island, N. Brazil 297
—— —— —— S. Brazil ... 296
Annapolis, Maryland ... 283
—— Nova Scotia ... 281
Anne, St., Island ... 299

PLACES—continued.

Page.
Annisquam 282
Anno Bon Island 322
Anns, St., C. Breton I 281
—— —— England 304
Anowik Island 288
Antareh, Ras 324
Antibes 316
Anticosti Island 280
Antigua 294
Antipodes Island 350
Antivari 318
Antofagasta 301
Antonina 297
Antonio, Port 293
—— San, Cape, Argentina 298
—— —— —— Cuba 293
—— —— Mt. and Island 303
—— —— Port, Argentina 298
—— —— —— Chile 300
—— —— Sierra ...
Antwerp 313
Aoga Shima 340
Aomori 340
Aor, Pulo 331
Aotea 355
Apaiang Island 342
Apalachicola 284
Apamama 342
Aparri 334
Apenrade 311
Apo Islet 334
Apostle Rocks 299
Arago Cape 289
Araish, El 321
Arakam Island 342
Araktcheff Island 349
Aran Island 306
Aransas Pass 284
Aranuka Island 342
Aratika Island 349
Arcadins Islands 294
Arcas Cays 285
Archangel 356
Ardassier Islands 332
Ardrossan 305
Arena de la Ventana 290
—— Point, California 289
—— —— L. California 290
Arenas Cay 285
Arendal Inlet 308
Arentes Island 332
Argentina 298
Argostoli, Port 319
Arica 301
Arichat Harbor 281
Arkona 311
Armeghon 329
Arnheim, Cape 351
Arno Atoll 343
Arorai Island 342
Arran Island 306
Arrowsmith Islands 343
Arsuk 356
Artaki Bay 320
Arthur River 354
—— Port 338
Aru Islands 332
Arvoredo Island 297
Ascension Bay 285
—— Island 303

Page.
Ashburton River 355
Ashrafi Island 324
Asia Rock 301
Assateague Island 283
Assens 312
Assumption Island 326
Astoria 289
Asuncion Island, Ladrones 344
—— —— L. California 290
Atalaia Point 296
Athens 319
Atico 301
Atiu Island 350
Atka Island 287
Atkinson Point 289
Attu Island 287
Auckland 354
—— Islands 350
Audierne 314
Augusta 282
—— Port, Australia 352
—— —— Sicily 317
Augustenberg 311
Augustin, St., Cape, Brazil 296
—— —— —— Philippines 335
Augustine, San, Island 345
—— St., Bay 326
—— —— Harbor 284
Aurh Island 343
Aurora Harbor 356
—— Island 347
Austral Islands 350
Aux Cayes 294
Avarena Point 294
Aves Island 295
Aviles 314
Avlona 318
Axim Bay 322
Awa Sima 340
Ayamonte 315
Ayer Bangis 330
Ayr 305

Baago Island 312
Babayan Claro Island 334
Baccalieu Island 279
Bagamoyo 324
Bahaltolis Island 336
Bahama Island 292
Bahia, Brazil 296
—— Colombia 295
—— de Cadiz Cay 293
—— Honda, C. America 291
—— Honda 293, 295
Bahrein Harbor 327
Baitiqueri, Port 293
Bajo Nuevo 285
Bajuren Island 333
Baker Islet 342
Bakers Island 281
Baklar 320
Balábac Island 333
Balaklava Bay 320
Balari Pass 350
Balasor River 329
Balatangi 357
Balayan 334
Bald Isle 352

Page.
Balfour Rock 327
Bali Island 332
Balingtang Islands 334
Ballena Bay 291
Balls Pyramid 350
Ballum 311
Ballycottin 307
Balstrum 312
Balta Island 305
Baltic Port 310
Baltimore 283
Bampton Island 347
Banda Island 332
Banderburum 327
Bandjermasin 333
Bangkaru Islands 330
Bangkok 336
Bangor 281
Bangs Havn 356
Banjuwangi 331
Banka Island 331
—— Strait 331
Bankot 328
Banks Strait 352
Bantal 330
Bantam 331
Bantenan 331
Banton Island 335
Bantry Bay 306
Baracoa 292
Barataria Bay 284
Baratoube Bay 326
Barbados Island 295
Bárbara, Santa, California 289
—— —— Island 289
—— —— Mexico 291
—— —— Port 299
Barbe, St., Island 331
Barbuda 294
Barcelo Bay 299
Barcelona, Spain 315
—— Venezuela 295
Bardsey Island 304
Barfleur, Cape 313
Bari 317
Barker Islets 351
Barnard Island 353
Barnegat Inlet 283
Barneveldt Islands 298
Barnstable 282
Barra Head 305
—— São João 297
Barren Island 339
—— —— West 338
Barrier, Great, Island 354
Barrington Island 342
Barrow Island, Australia 351
—— —— Tuamotu Arch 349
—— Point 287
Bartholomew, St 294
—— —— Cape 298
Bartolomé, San 290
Barton, Port 334
Baru, Point 330
Barung Island 331
Bas, De, Island 313
Basdorf 311
Basianang Bay 335
Básidú 328
Basilan Island 336

PLACES—continued.

Page.
Baskerville, Cape...... 351
Basrah...... 327
Bass Islets...... 350
Bassa, Grand...... 322
Bassas Rocks...... 329
—— da India...... 326
Bassein, Burma...... 329
—— India...... 328
—— River...... 329
Basseterre...... 294
Bastia...... 316
Bastion, Cape...... 337
Basto...... 308
Batabano...... 293
Batalden Island...... 308
Batan Island...... 334
—— Port...... 335
Batangas...... 334
Batavia...... 331
Batbatan Island...... 335
Bate Islands...... 339
Bateman Bay...... 352
Bath...... 282
Bathurst...... 321
—— Island...... 351
Batian Island...... 333
Batoe Islands...... 330
Batoe Toetong...... 330
Batoum...... 320
Batticaloa...... 329
Battle Islands...... 279
Batty Bay...... 355
Baubeltaub Island...... 344
Bauld Cape...... 279
Baxo Nuevo...... 293
Bay of Islands...... 354
Baynes Sound...... 288
Bayonnaise Island...... 340
Bayonne...... 314
Bazaruto Island...... 323
Beachy Head...... 304
Beale Cape...... 298
Bear Island...... 356
—— Cape...... 316
Beata Island...... 294
Beaufort, N. Carolina...... 283
—— S. Carolina...... 283
—— Port...... 323
Beaver Harbor...... 288
Beaver-tail Light...... 282
Bec du Raz...... 314
Beda's, Al...... 327
Bedford, Cape...... 353
Bees, St...... 305
Beeves Rocks...... 306
Beirut...... 320
Bel Air...... 326
Belfast...... 281
—— Bay...... 306
Belgrano...... 298
Belize...... 286
Bell Island...... 279
—— Rock, Scotland...... 305
Bellavista Cape...... 316
Belle Isle, France...... 314
Belle Isle, Labrador...... 279
Bellingshausen Island...... 348
Bellone, Cape...... 326
Ben Ghazi...... 321
Benbane Head...... 306

Page.
Bender Erekli...... 320
Benedicto, San, Island...... 291
Benevente...... 297
Benguela...... 322
Benicia...... 289
Benidonne...... 315
Benin River...... 322
Benito, San, Island...... 290
Benkulen...... 330
Bento, San, River...... 322
Benzert...... 321
Bequia Island...... 295
Berbera...... 324
Berdiansk...... 320
Bergen, Germany...... 311
—— Norway...... 308
Berikat...... 331
Bering, Cape...... 342
—— Island...... 341
Berlanga Island...... 315
Berlin...... 311
Bermeja Head...... 298
Bermudas...... 303
Bernal Chico...... 285
Bernardo Islands...... 348
Berwick...... 305
Besuki...... 331
Betrapar Islet...... 325
Beverly...... 282
Beyt...... 328
Bhaunagar...... 328
Bianche Point...... 318
Biarritz...... 314
Bickerton Island...... 351
Bideford...... 304
Bidstone...... 305
Bierneborg...... 309
Bigar Islet...... 343
Bikini Islands...... 343
Bilbao...... 314
Bille, Cape...... 356
Billiton Island...... 331
Bindloe Island...... 342
Bintang Hill...... 330
Bintoean...... 330
Bird Island, Australia...... 353
—— —— Bahamas...... 292
—— —— Banda Sea...... 332
—— —— N. Pacific...... 344
—— —— Seychelle Islands. 325
—— —— Tuamotu Arch...... 349
—— —— W. Africa...... 321
—— Islands...... 323
Birneys Island...... 345
Bismarck, Cape...... 356
Bittern Rocks...... 340
Bjuroklubb...... 309
Blaabjerg...... 312
Black Head...... 279
—— Point Bay...... 322
—— Stairs Mountain...... 307
Blackness...... 305
Blacksod Point...... 306
Blair, Port......
Blaize, St...... 323
Blanco Cape, N., Africa...... 321
—— —— Oregon...... 289
—— —— Peru...... 302
—— —— Africa...... 321
—— Peak...... 287

Page.
Blankenberghe...... 313
Blas, San, Argentina...... 298
—— —— Cape, Florida...... 284
—— —— Mexico...... 291
Blasket Islands...... 306
Bligh Island...... 349
Blighs Cape...... 327
Blimbing Bay...... 330
Blinyu...... 331
Block Island...... 282
Bloody Foreland...... 306
Bluefields...... 286
Bluff Harbor...... 355
Boar Islands...... 280
Boavista Island...... 303
Bobara Rock...... 318
Bocas del Toro...... 287
Bodie Island...... 283
Bogense...... 312
Bogsher...... 309
Bohol Island...... 335
Bojador, Cape...... 321
Bojeador, Cape...... 334
Bola-Bola Island...... 349
Bom Abrigo Islet...... 297
Bombay...... 328
Bon, Cape...... 321
—— Point...... 330
Bona...... 321
Bonacca Island...... 286
Bonaire Island...... 295
Bonaventure Head...... 279
—— Island...... 280
Bonavista Cape...... 279
Bongao Island...... 336
Bonham Islands...... 343
Bonifacio...... 316
Bonin Islands...... 345
Boobjerg...... 312
Booby Island, Leeward Is.. 294
—— —— Queensland...... 353
Boompjeo Island...... 331
Boon Island...... 282
Borda, Cape...... 352
Bordeaux...... 314
Bordelaise Island...... 343
Borja Bay...... 299
Bornholm...... 312
Borodino Islands...... 345
Boscawen Island...... 348
Bosphorus...... 320
Boston...... 282
Botel Tobago Sima...... 338
Bougainville, Cape...... 351
—— Island...... 346
Bougaroni, Cape...... 321
Boulogne...... 313
Bounty Islands...... 350
Bourbon, Cape...... 327
Bouro Island...... 332
Bouton Island...... 333
Bouvets Island...... 304
Bowditch Islet...... 345
Bowen, Port, Australia...... 353
—— —— Baffins Bay...... 355
Bowling Green, Cape...... 353
Boyanna Bay...... 326
Bradore Bay...... 280
Brala, Pulo...... 336
Bras, Pulo...... 330

PLACES—continued.

Page.
Brass River 322
Brava Island, C. Verde Is. 303
—— E. Africa 324
Brazos Santiago 284
Bray Head 307
Breaker Point 337
Bremerhaven 311
Bremerton 289
Brest 314
Brewers Lagoon 286
Bridgeport 283
Brielle 313
Brill Reef 332
Brindisi 317
Brisbane 353
Bristol, England 304
—— Rhode Island 282
Britannia Island 350
Broadhaven 306
Broken Bay 352
Bronnosund 307
Brothers Island, Red Sea 324
—— Islets, China 337
Broughton Bay 338
—— Head 339
—— Island 341
—— Rock 340
Brunet Island 280
Bruni River 333
Brunswick, Georgia 283
—— Maine 282
Bruny, Cape 354
—— Island 354
Brussels 313
Brusterort 310
Bryer Island 281
Bubuan Island 336
Bucas Island 335
Buchanness 305
Buddonness 305
Budrum 320
Buliluyan, Cape 333
Budua 318
Buenaventura 302
—— San 289
Buenos Ayres 298
Bugui Point 335
Buitenzorg 331
Buka Island 346
Bulipongpong Island 336
Bülk 311
Bull Harbor 288
—— Rock 306
Bullock Bay 341
Burg 311
Burghaz 320
Burias Island 335
Burin Harbor 279
Burnett River 353
Burntcoat Head 281
Burrh Island 343
Busios 297
—— Islets 297
Bustard Head 353
Busuanga Island 334
Büsum 311
Butt of Lewis 305
Button Islands 279
Byam Martin Island 349
Byron Island 342

Page.
Caballo Island 334
Cabeceira, Cape 323
Cabeza de Vaca 300
Cabrera Island 316
Cabron Cape 293
Cabrut Islet 325
Cadaques 315
Cadiz 315
Cadmus Island 349
Caen 313
Cagayan Jolo Island 336
Cagayanes Islands 336
Cagliari 316
Caiçara 296
Caicos Island 292
—— West, Cay 292
Calaan, Point 335
Calais, France 313
—— Maine 281
Calavite, Monte 334
Calayan Island 334
Calbuco 300
Calcasieu Pass 284
Calcutta 329
Caldera 300
Caldy Island 304
Calebar River, New 322
—— —— Old 322
Caledonia Harbor 287
Calf of Man 305
Calicut 328
Calimere Point 329
Callao 301
Calpe 315
Caluya Island 334
Calvi 316
Camamu 296
Camaron Cape 286
Camasusu Island 335
Cambay 328
Cambria 297
Cambridge, England 304
—— United States 282
Camiguin Island, Luzon 334
—— —— Mindanao 336
Cammin 310
Campbell, Cape 355
—— Island 350
Campeche 285
Campobello Island 281
Canaria, Gran, Island 303
Canaveral Cape 284
Cancun Island 285
Candia Island 319
Candon 334
Cannes 316
Cannonier Point 325
Canoas Point 290
Canso, Cape 281
—— North 281
Canton 337
—— Island 345
—— Pulo 336
Cantyre 305
Cape Haitien 293
Cape Town 323
Cape Verde Islands 303
Capel Island 307
Cape d'Istria 317
Capones Islet 334

Page.
Capraia Island 316
Caprera Island 316
Capri Island 317
Capricorn, Cape 353
Car Nicobar 330
Carabane 321
Carabao Island 335
Caraques Bay 302
Caratasca Lagoon 286
Caravellas 297
Carbon, Cape 321
Carbonera Cape 316
Cardamum Islet 325
Cardenas 293
Cardiff 304
Careys Islands 355
Cargados Carajos 325
Caribana Point 295
Carimare Mountain 296
Carimata Island 331
Carlingford Lough 307
Carlobago 318
Carloforte 316
Carlos, San 300
—— —— Point 290
Carmen Island 285
Caroline Islands, N. Pacific 343
—— —— S. Pacific 345
Carousel Island 280
Carreta Mountain 301
—— Point 287
Carreto, Port 287
Carrizal, Port 300
Cartagena, Colombia 295
—— Spain 315
Cartago Mountain 286
Carteret Cape 313
—— Harbor 346
Cartwright Harbor 279
Carupano 295
Carysfort Island 349
—— Reef 284
Cascade Point 355
Casilda 293
Casquets Rocks 313
Cassini Island 351
Castillos 298
Castle Island 292
Castlehaven 306
Castro 300
—— Urdiales 314
Cat Island 284
Catalina Harbor 279
—— Sta., Island 289
Catanduanes Islands 335
Catania 317
Catastrophe, Cape 352
Catbalogan 335
Catharine Point 299
—— St 304
Catherina, Sta., Island 297
Cato Island 347
Catoche Cape 285
Cattaro 318
Cavite 334
Caxones 286
Cayenne 296
Cayeux 313
Caymans 293
Cazza Island 318

PLACES—continued.

Page.
Ceará ... 296
Cebu Island ... 335
Cedar Keys ... 284
Cedeira ... 314
Ceicer de Mer Island ... 337
Celebes ... 333
Centinela Islet ... 295
Ceram Island ... 332
Cerros Island ... 290
Cestos ... 322
Cette ... 316
Ceuta ... 321
Ceylon ... 329
Chacachacare Island ... 296
Chacopata ... 295
Chagos Arch ... 325
Chagres ... 287
Chahbar Bay ... 328
Chala Point ... 301
Chaleur Bay ... 280
Challenger, Cape ... 327
Chama Bay ... 322
Cham-Callao Island ... 336
Chamé, Point ... 291
Chamisso Island ... 287
Champerico ... 291
Chañaral Bay ... 300
—— Island ... 300
Chandeleur Islands ... 284
Chao Islet ... 301
Chapel Island ... 337
Chapu ... 338
Charles Cape ... 283
—— Island, Chile ... 299
—— —— Galapagos Group ... 342
—— —— Hudson Strait ... 279
Charleston ... 283
Charlottetown ... 280
Chateau Bay ... 280
Chatham Harbor ... 282
—— Island, Galapagos Group ... 342
—— —— S. Pacific ... 350
Chatte Cape ... 280
Chaume, La ... 314
Chausey Islands ... 313
Chedubah Island ... 329
Chemulpo ... 339
Chentabun River ... 336
Chepillo Island ... 291
Cherbourg ... 313
Cheribon ... 331
Cherso ... 317
Chicarene Point ... 291
Chidleigh Cape ... 279
Chifoo ... 338
Chignecto Cape ... 281
Chignik Bay ... 288
Chilca Point ... 301
Chimba Bay ... 301
Chimbote ... 301
Chincha Islands ... 301
Chinchin Harbor ... 337
Chinchorro Bank ... 285
Chin-hai ... 338
Chino Bay ... 337
Chirambiri Point ... 302
Chirikof Island ... 288
Chiriqui Lagoon ... 287
Chirivico ... 293

Page.
Chitlac Islet ... 325
Chittagong River ... 329
Choda Island ... 339
Choiseul Island ... 346
—— Port ... 326
Choros Islands ... 300
Christiana Islands ... 319
Christiania ... 308
Christianshaab ... 356
Christianso Island ... 372
Christianssand ... 308
Christiansund ... 307
Christmas Cove ... 299
—— Harbor ... 327
—— I., Indian Ocean ... 327
—— —— N. Pacific ... 342
Christopher, St ... 294
Chuapa River ... 300
Chuluwan Island ... 323
Chupat River ... 298
Churruca, Port ... 299
Chusan Islands ... 338
Ciaris Island ... 291
Cica, Mount ... 318
Cienfuegos ... 293
Ciotat ... 316
Cispata, Port ... 295
Citta Nuova ... 317
Civita Vecchia ... 316
Clara, Sta ... 289
Clare Island ... 306
Claremont Point ... 353
Clarence Harbor, Bahamas ... 292
—— Port, Alaska ... 287
—— River ... 352
Clarion Island ... 291
Claushavn ... 356
Clear Cape ... 306
Clearwater Point ... 280
Clerke Island ... 349
Clermont Tonnere Island ... 349
Cleveland, Cape ... 353
Clew Bay ... 306
Clifden Bay ... 306
Clipperton Island, Mexico ... 291
—— —— N. Pacific ... 344
Clonard, Cape ... 339
Coast Castle, Cape ... 322
Cobija ... 301
Cobre Bay ... 301
Cochin ... 328
Cockell Islet ... 351
Cockscomb Mountain ... 286
Coconada ... 329
Cocos Island, C. America ... 291
—— —— N. Pacific ... 342
Cod, Cape ... 282
Codera Cape ... 295
Codfish Island ... 355
Codroy Island ... 280
Coetivy Island ... 326
Coffin Bay ... 352
—— Island, Madagascar ... 326
—— —— Nova Scotia ... 281
Cofre de Perote Mt ... 285
Coiba Island ... 291
Coimbra ... 315
Colberg ... 310
Colbert Islet ... 351
Coles Point ... 301

Page.
Colina Redonda ... 301
Colnett Bay ... 290
Colombo ... 329
Colon ... 287
Colonia ... 298
Colonna, Cape, Greece ... 319
—— —— Italy ... 317
Columbia, Cape ... 355
Columbretes Islands ... 315
Columbus Island ... 287
Colville, Cape ... 354
Comau Inlet ... 300
Comandatuba ... 297
Commerson Island ... 346
Comorin, Cape ... 328
Comoro Island ... 326
Conceição ... 297
Conception Island ... 292
—— Point ... 289
Conde ... 296
Condor Cove ... 300
Condore Islands ... 337
Conducia ... 323
Conejo, El, Point ... 290
Coney Island ... 337
Confites Cay ... 292
Congo River ... 322
Congrehoy Peak ... 286
Connétable Islet ... 296
Constantinople ... 320
Constitution Cove ... 301
Contas ... 296
Conte, Port ... 316
Contoy Island ... 285
Conway, Cape ... 353
—— Reef ... 350
Cook Cape ... 288
—— Mountain ... 353
Cooper, Port ... 355
Copenhagen ... 312
Copiapo ... 300
Copper Island ... 341
Coquet Island ... 305
Coquille Island ... 343
Coquimbo ... 300
Coral Island ... 297
—— Islet ... 297
Corcovado Volcano ... 300
Cordouan, Point ... 314
Corfu ... 319
Coringa Islands ... 347
Corinto ... 291
Cork, Ireland ... 307
—— Port, Staten Island ... 298
Cormorant Island ... 288
Corn Islands ... 286
Cornwallis Islands ... 344
—— Port ... 329
Coro, Vela de ... 295
Coromandel Harbor ... 354
Coronation Island ... 304
Corregidor Island ... 334
Corrientes, Cape, Argentina ... 298
—— —— Colombia ... 302
—— —— Mexico ... 291
—— —— S. Africa ... 323
Corsarios Bay ... 295
Corseulles, Port ... 313
Corso, Cape ... 316
—— Mountain ... 299

PLACES—continued.

Page.
Corti 316
Coruña 314
Corvo Island 302
Coslin 310
Cosmoledo Island 327
Cotinguiba 296
Cotrone 317
Coubre, Point de la 314
Courtown Cays 286
Coutances 313
Cove Rock 323
Cow Head 280
Coy Inlet 298
Cozumel Island 285
Cracker Bay 298
Crassok Point 331
Crawl Cay 287
Crescent City 289
Cretin, Cape 346
Creux, Cape 315
Cristoval, San, Island 346
Crocker Island 349
Croisic 314
Croix, St 294
Croker, Cape 351
Crooked Island 292
Crozet Islands 327
Cruz Cape 293
—— Sta., Brazil 297
—— —— California 289
—— —— Island 289
—— —— Islands, Philippines 335
—— —— —— S. Pacific 347
—— —— Luzon 334
—— —— Port 298
Cuad Basang Island 336
Cuba
Culebra 291
Culebrita Island 294
Culion Island 334
Cullera, Cape 315
Culver Point 352
Cumana 295
Cumberland Island 353
Cumshewa Harbor 288
Cupchi Point 337
Cupica Bay 302
Curaçao Island 295
—— —— Little 295
Currimao 334
Currituck Beach 283
Curtis Island 353
—— Port 353
Curzola Island 318
Cuttyhunk Light 282
Cuvier, Cape 351
—— Island 354
Cuxhaven 311
Cuyo Island 334
Cyprus 320

Dædalus Shoal 324
Dago Island 310
Dairen Wan 338
Dakar, Port 321
Dalcahue 300
Dale Point 351
Dalrymple Harbor 336
—— Port 354

Page.
Dalupiri Island 334
Dame Marie, Cape 294
Damghot 327
Damma Island 332
Danger Islands 348
Dangerous Rock 337
Dannesbrog Island 356
Danube River 320
Dantzig 310
Dapitan 336
Dardanelles 320
Dar el Beida, Cape 321
Dar-es-Salaam 324
Darien Harbor 291
—— Georgia, U. S 283
Darsserort 311
Darwin, Port 351
Dato Island 331
Datu, Point 330
Dauphin, Fort 326
Davao 335
Davey, Port 354
Davids, St., Island 303
De Freycinet Islets 351
De Kastri 341
De Peysters Island 345
Deadman Rock 280
Deception Island 304
Deimaniyeh 327
Delagoa Bay 323
Delgada Point 299
Delgado, Cape 324
—— Point 298
Demerara 296
Denia 315
Denis, St 326
Denison, Port 353
D'Entrecasteaux Islands 347
—— Point 351
D'Urville Island 355
—— Point 346
Deseado, Cape 299
Desert, Mt., Rock 281
Desertas 303
Desirade 294
Desire, Port 298
Desolation, Cape 298
Dia Fjeld 357
Diamond Harbor 329
—— Point 330
Diedrichshagen 311
Diego Garcia 325
—— Ramirez Island 298
—— San 289
—— —— Cape 298
Dieppe 313
Digges Islands 279
Dimas 293
Dimasalasan, Port 334
Dinding Channel 329
Dingle Bay 306
Diomede Island 287
Direction, Cape 353
—— Island 331
Disappointment, Cape, Sib. 341
—— —— Washington 289
Discovery Harbor 355
Disei Island 324
Diu Head 328
Dix Cove 322

Page.
Djabon, Point 330
Djambi 330
Djursten 309
Dnieper Bay 320
Doc Can Islet 336
Dodd Island 337
Dog Island 294
Domar, Pulo 331
Domesnes 310
Domingo, San, Point 290
—— St., Cay 292
Dominica 295
Donaghadee 306
Dondra Head 329
Donegal Bay 306
Double Island 329
—— —— Point 353
—— Peak Island 337
Douglass Rocks 345
Dounpatrick Head 306
Douvres Rocks 313
Dover Point 352
Drei Cap Peninsula 346
Drepane, Port 319
Dröbak 308
Drogheda 307
Dromedary Mountain 352
Drummond Island 342
Dublin 307
Ducie Island 349
Duff Islands 347
Duke of Clarence Island 345
—— —— York I., N. Britain 346
—— —— —— S. Pac. 346
Dulce Gulf 286
—— River 286
Dulcigno 318
Dumaguete 335
Dumaly Point 334
Dumford Point 323
Duncan Island 342
Dundee, Rock of 299
Dundrum Bay 307
Dungarvan 307
Dungeness 304
—— New 289
—— Point 299
Dunkerque 313
Dunnet Head 305
Duperrey Islands 343
Duppel 311
Durazzo 318
Durnford, Port 324
Dussejour, Cape 351
Dwarka 328

Eagle Island 306
Earakong Island 344
East Cape, Madagascar 326
—— —— New Zealand 354
—— —— Siberia 342
—— Dog Island 337
—— Island, Crozet Is 327
—— —— Magdalen Is 280
Easter Island 350
Eastport 281
Eau Island 343
Eauripik Islands 343
Ebon Atoll 343

PLACES—continued.

Page.
Eckemforde 311
Eclipse Harbor 279
—— Islands 351
Eddystone 304
—— Point 354
Eden Harbor 299
Edenshaw Cape 288
Edenton 283
Edinburgh 305
Eeragh Island 306
Egedesmunde 356
Eggegrund Islet 309
Egmont Mountain 354
—— Port 303
Eimeo Island 349
Ekholm Islet 310
Elba Island 316
Elbing 310
Elena, St., Port 298
—— Sta., Point 302
Elephant Bay 322
Eleuthera Island 292
Elias, St., Mount 288
Elizabeth Bay 322
—— Cape 282
—— City 283
—— Harbor 355
—— Island, Chile 299
—— —— Tuamotu Arch 349
—— Port 323
Elizabeth Reef 350
Ellice Islands 345
Emden 312
Emu Bay 354
Enánger 309
Endelave Island 312
Enderbury Island 345
Enderby Island 351
Endermo 341
Enfant Perdu Island 296
Engano, Cape 293
Engaño, Cape 334
Engano Island 330
Engelholm 308
English Cay 285
Eniwetok Islands 343
Enragé, Cape 281
Ensenada 290
Entry Island 280
Erromango Island 347
Erronan Island 347
Escarceo Point, Phil. Is 334
—— ——, Venezuela 295
Eschholtz Islands 343
Escondido, Port 293
Escudo de Veragua 287
Escumenac Point 280
Esdu Island 325
Esmeralda Islet 296
—— River 302
Espada Point, Colombia 295
Espenberg, Cape 287
Esperanza Inlet 288
Espiritu Santo Bay 297
—— —— Cape 299
Esquimalt 288
Essington, Port 351
Estaca Point 314
Estangues Point 295
Estevan Point 288
Etches, Port 288

Page.
Eten Head 302
Eu, Pulo 331
Eureka 289
Euripo Strait 319
Europa Island 326
Eustatius, St 294
Evangelistas Island 209
Evaristo, San 290
Expedition Bay 341
Exuma, Great, Island 292

Faero Islands 302
Fair Isle Skroo 305
Fairy, Port 352
Faiu, W., Islet 343
Fakaofu Islet 345
Fakarana Island 349
Falkenberg 308
Falkland Islands 304
Falmouth, England 304
—— Jamaica 293
False, Cape 294
False Cape Horn 298
—— Point 329
Falster Island 312
Falsterbö 308
Famagusta 320
Famine, Port 299
Fanad Point 306
Fanning Island 342
Fano Island, Adriatic 319
—— —— Denmark 312
Farallon Islet 289
Faraulep Island 343
Farewell, Cape, Greenland 356
—— —— New Zealand 355
Farina, Cape 321
Farisan Island 325
Farn Island 305
Faro Island, Sweden 309
—— of Messina 317
Farquhar Islands 326
Farrall Rock 286
Farralon de Pajaros 344
Fartak, Ras 327
Fastnet Rock 306
Father Point 280
Fatsizio Island 340
Fatu Hiva Island 345
—— Huku Island, Galapagos 342
—— —— —— Marquesas 345
Fatuna Island 348
Fayal Channel 302
—— Island 302
Fécamp 313
Felipe, San, Cays 293
—— —— Point 290
Felix, St., Island, Chile 300
—— —— —— S. Pacific 350
Fenerive Point 326
Fermin Point 289
Fernandina 284
Fernando Noronha 303
—— Po Island 322
—— San, Cuba 292
—— —— River 285
—— —— Port, P. I 334
—— —— Trinidad 296
Férolle Pena., New 280
Ferro Island 303
Ferrol 314

Page.
Fetouhouhou Island 345
Feys Island 343
Fidonisi Island 320
Figari Cape 316
Filzand Island 310
Finisterre, Cape 314
Firase Rocks 339
Fire Island 283
Firmin, San 290
Fischausen 310
Fish, Great, Bay 322
—— Little, Bay 322
Fiskernaes 356
Fitz Roy River 351
Fiume 317
Five Fathom Bank 283
Flamborough 305
Flamenco 300
—— Island 291
Flat Island 325
Flattery, Cape 289
Flensberg 311
Flesko, Cape 333
Flinders Island 352
—— Islands 353
—— River 353
Flint Island 345
Florence 316
Flores Island, Azores 302
—— —— Indian Arch 332
—— —— Uruguay 298
Florida Island 346
Flower Cove 280
Flushing 313
Fly River 346
Foerder Islet 308
Fogo Island 303
Föhr 311
Foreland, North 304
—— South 304
Formigas Islands 302
—— Shoal 293
Formosa Island 338
Fornaes 312
Forsmark 309
Forsyth Point 288
Forth Mountain 307
Fortune Island 292
Foulwind, Cape 355
Four, Le, Rock 314
Fowey Rocks 284
Fowler Point 352
Frances, Cayo 292
Francis Island 342
—— St., Cape, C. Colony 323
—— —— —— Newf'dl'd 279
Francisco, San 289
—— —— Cape 302
—— —— Head 301
—— —— River 296
—— São 297
Frankland Island 353
Franklin Harbor 352
Franz Josef Land 356
Fraser River 289
Fraile Rock 294
Frayles Point 301
Frederick, Port 354
Frederik Hendrik, Cape 354
Frederikshaab 356
Frederiksthal 356

PLACES—continued.

Page.
Frederiksvaern.......... 308
Fredriksten.......... 308
Freels Cape.......... 279
Frehel, Cape.......... 313
Freikallen.......... 307
Fremantle.......... 351
French Cay.......... 292
—— Frigate Shoal.......... 344
Freycinet, De, Islets.......... 351
—— Peninsula.......... 354
Frio, Cape, Brazil.......... 297
—— —— W. Africa.......... 322
—— Port.......... 297
Froward Cape.......... 299
Fruholm.......... 307
Frying Pan Shoals.......... 283
Fuenterrabia.......... 314
Fuerta Ventura Island.......... 303
Fuerte Island.......... 295
Fuga Island.......... 334
Fugle Huk.......... 357
Fulanga Island.......... 348
Fulehuk.......... 308
Funafuti Island.......... 345
Funk Island.......... 279
Funkenhagen.......... 310
Furen Islet.......... 308
Fushiki.......... 340
Futuna Island.......... 347

Gaalong Bay.......... 337
Gabo Island.......... 352
Gabriel Mountain.......... 306
Gaeta.......... 316
Gafor Island.......... 325
Galapagos Islands.......... 342
Galera Point, Ecuador.......... 302
—— —— Trinidad.......... 296
Galgenberg.......... 311
Galiola Rock.......... 318
Galita Island.......... 321
Gallant, Port.......... 299
Galle, Point de.......... 329
Gallegos River.......... 298
Galley Head.......... 307
Gallinas River.......... 322
Gallipoli, Italy.......... 317
—— Turkey.......... 320
Galloway, Mull of.......... 305
Galveston.......... 284
Galway.......... 306
Gambier Island.......... 349
Gange.......... 309
Gannet, Outer, Island.......... 279
—— Rock.......... 281
Gap Rock.......... 337
Garcia d'Avila.......... 296
Gardiner Island.......... 344
Gardners I., Long Island.......... 282
—— —— S. Pacific.......... 345
Garras, Little.......... 330
Gaspar, Island and Strait.......... 331
—— Rico Reef.......... 344
Gasparilla Island.......... 284
Gaspé Cape.......... 280
Gata, Cape, Cyprus.......... 320
—— —— de, Spain.......... 315
Gaujam.......... 329
Gay Head.......... 282
Gebey Islands.......... 333

Page.
Geelong.......... 352
Gefle.......... 309
Genoa.......... 316
George, Fort, Cay.......... 292
—— St., Cape, Florida.......... 284
—— —— —— Newf'dl'd.......... 280
—— —— —— Nova Scotia.......... 281
—— —— Island, Alaska.......... 287
—— —— —— Azores.......... 302
Georges Island.......... 290
—— St., Cay.......... 285
Georgetown.......... 283
Georgia, South, Island.......... 304
Geronimo, San, Island.......... 290
Geyser Reef.......... 326
Gharib, Ras.......... 324
Ghir, Cape.......... 321
Gibara.......... 292
Gibdo Island.......... 335
Gibraltar.......... 315
Giglio Island.......... 316
Gijon.......... 314
Gilbert Islands.......... 342
Gillolo Island.......... 333
Ginger Cay.......... 292
Girgenti.......... 317
Gizau.......... 325
Gizo Island.......... 346
Glas Island.......... 305
Glasgow.......... 305
Glashedy Island.......... 306
Glenan Islands.......... 314
Glorioso Islands.......... 326
Gloucester Island, Aus.......... 353
—— —— Tuamotu Arch.......... 349
—— Massachusetts.......... 282
Glover Reef.......... 285
Gnarp.......... 309
Goa.......... 328
Gobernadora.......... 293
Godhavn.......... 356
Godthaab.......... 356
Goedereede.......... 313
Golam Head.......... 306
Gomenitza.......... 319
Gomera Island.......... 303
Gonaïves.......... 294
Gonave Island.......... 294
Good Hope, Cape, Africa.......... 323
—— —— —— China.......... 337
—— —— Island.......... 348
—— Success Bay.......... 298
Goose Island.......... 352
Gopalpur.......... 329
Goram Islands.......... 332
Gorda Cay.......... 286
—— Point.......... 301
Gore, Port.......... 355
Goree Island.......... 321
—— Road.......... 298
Gorgona Island.......... 302
Goro Island.......... 348
Gorontalo.......... 333
Goto Island.......... 339
Gottenburg.......... 308
Gottland Island.......... 309
Gough Island.......... 303
Gozier Islet.......... 294
Gozo Island.......... 317
Gracias á Dios, Cape.......... 286

Page.
Graciosa Island.......... 302
Grado.......... 317
Grand Manan Island.......... 281
—— Port.......... 325
—— Riband Island.......... 316
Grande Point.......... 301
Granitz.......... 311
Granville.......... 313
Grappler, Port.......... 299
Grave, Point de.......... 314
Gravelines.......... 313
Gready Harbor.......... 279
Great Bird Rock.......... 280
—— Rock Head.......... 286
Green, Cape.......... 352
—— Island, Labrador.......... 279
—— —— Newfoundland.......... 280
—— —— Nova Scotia.......... 281
Greenly Island.......... 280
Greenspond Island.......... 279
Greenwich.......... 304
—— Island.......... 343
Gregory, Cape.......... 299
—— Port.......... 351
Grenada.......... 295
Grenville, Cape.......... 353
Grey River.......... 355
Greytown.......... 286
Griefswald.......... 311
Griefswalder Oie.......... 311
Grim, Cape.......... 354
Grimsey Norddranger.......... 357
Grip.......... 307
Gris Nez Cape.......... 313
Groote Eylandt.......... 351
Groix, Island de.......... 314
Gross-Horst.......... 310
Grouin du Cou, Point de.......... 314
Gruizza Rock.......... 318
Gryto.......... 307
Guadalcanal Island.......... 346
Guadeloupe, L. California.......... 290
—— West Indies.......... 294
Guafo I.......... 300
Guaineco Islands.......... 299
Guaira, La.......... 295
Guaja Shima.......... 339
Guam Island.......... 344
Guana, Little, Cay.......... 292
Guanape Islands.......... 301
Guanica.......... 294
Guantanamo.......... 293
Guarapiri Islets.......... 297
Guaratiba, Cape.......... 297
Guardafui, Cape.......... 324
Guascama Point.......... 302
Guatulco, Port.......... 291
Guayaquil.......... 302
Guaymas.......... 290
Guerande.......... 314
Guerin Island.......... 339
Guguan Island.......... 344
Guimaras Island.......... 335
Guiuan.......... 335
Guldager.......... 312
Gull Island, Little.......... 282
Gullan, San, Island.......... 301
Gun Cay.......... 292
Gunong Api Island.......... 332
Gutzlaff Island.......... 338

PLACES—continued.

Page.
Gwadar Bay 328
Gwatar Bay 328

Habana 293
Habibas Island 321
Hacha, Rio de la 295
Haddington, Port 338
Haedic Island 314
Hafun, Ras 324
Hagenmeister Island 287
Hague, Cape la 313
—— The 313
Haiduong 336
Haifong 336
Haifa 320
Hainan Island 337
Hai-yun-tan Island 338
Hakodate 341
Half Port Bay 299
Halfmoon Cay, Belize 285
—— —— Nicaragua 286
Halgan Island 350
Halifax 281
Haliguen, Port 314
Hall Island 343
—— Islands, Sir James 339
Halmahera I 333
Halmstad 308
Hals 312
Halt Bay 299
Halten Island 307
Hamberg 308
Hamburg 311
Hamilton Island 303
—— Mountain 289
—— Port 339
Hammamet Bay 321
Hammerfest 307
Hampton 282
Hamrånge 309
Hanalei 344
Hanfelah Bay 324
Hangklip, Cape 323
Hanjam Islet 328
Hannibal Isles 353
Hano Island 309
Hanoi 336
Hao Island 349
Haradsskar Islet 309
Haraiki Island 349
Harbor Grace 279
Harburg 311
Hardy, Sir C., Island 353
Harpe, La, Island 349
Harrison Cape 279
Hartlepool 305
Harvey, Port 288
Harwich 305
Hatteras Cape 283
Haustholm 312
Haute Island 281
Have, Cape la 281
Havre 313
Hawaii 344
Hayter Island 346
Heard Island 327
Hearts Content 279
Heau de Brehat 313
Heawandu Island 325
Hecate Bay 288

Page.
Hecate Cove 288
Hecla, Cape 355
Hed, Ras al 327
Hee-tah-doo Island 325
Hegadis Island 332
Heiligen Creutz 310
Hekkingen 307
Hela 310
Helena, St., Island 303
Helgoland 311
Heliers, St 307
Hellevoetsluis 313
Helliso 308
Hellyer Rocks 299
Helsinborg 308
Helsingfors 309
Helvick Head 307
Hendaye 314
Henderson Island 349
Henderville Island 342
Henlopen Cape 283
Henry Cape 283
—— Port 299
Heongsan, Port 338
Herald Cays 347
Hereheretue Island 349
Hermes, Cape 323
Hermit Island 346
Hermite Island 298
Herradura de Carrizal 300
Hervey Islets 350
Hesquiat Harbor 288
Hesselö Island 312
Hessenstein 311
Hestskjaer 308
Heve, Cape La 313
Hiaou Island 345
Hikueru Island 349
Hillswickness 305
Hilo 344
Himmittee Island 325
Hináwar 328
Hiogo 340
Hirado No Seto 339
Hirtshals 312
Hiva-Oa Island 345
Hjelm Islet 312
Hjertholm 307
Hjoerringa Mountain 307
Hoa-pin-su Island 338
Hobart Town 354
Hodeïdah Road 325
Hog Island, Indian Ocean 327
—— —— Virginia 283
—— Islands 286
Hogland Island 309
Hogolu Islands 343
Hogsty Reef 292
Hogulu Islands 343
Hohe Weg 311
Hohenschonberg 311
Hokianga River 355
Hokitika 355
Holborne Islet 353
Hole-in-the-Wall 323
Hollo Island 308
Holmestrand 308
Holmogadd 309
Holsteinberg 356
Holyhead 304

Page.
Hon Dau Island 336
Hondeklip Bay 323
Honfleur 313
Hongkong 337
Hon-Mó 336
Honolulu 344
Hood Island 342
—— Lord, Island 349
—— Point, Australia 352
—— Port, Cape Breton I 281
Hope Island 353
Hopedale Harbor 279
Hopes Advance, Cape 279
Hoppers Island 342
Horn, Cape 298
—— False Cape 298
—— Head 306
—— Island 284
Horne Island 348
Hornelen Mountain 308
Horsens 312
Horten 308
Hospital Bight 286
Hougue, Cape La 313
Houtman Rocks 351
Howaiyuh 327
Howe, Cape, East 352
—— —— West 351
—— Lord, Island 348, 350
—— —— Islands 346
—— Sound 288
Howland Islands 342
Howth Peninsula 307
Huaheine Island 349
Huanchaco Point 301
Huarmey 301
Huasco 300
Hudiksvalls 309
Huelva 315
Hügeberg 311
Hui-lang-san 337
Hull Island 350
Hulls Island 345
Hulu-shan Bay 338
Humber River 305
Humboldt 289
Humphrey Island 345
Hungwha Channel 337
Hunter Island, N. Hebrides 347
—— —— Tasmania 354
Hurds Island 342
Hurst Castle 304
Husum 311
Hvidingso 308

Iba 334
Ibayat Island 334
Ibbetson Island 343
Ibiza, Port 316
Icacos Point, Belize 286
—— —— Trinidad 296
Ichabo Island 322
Icy Cape 287
Ieraka 319
Ifalik Islands 343
Iglooik Island 355
Ignacio, San, Point 290
Iguape 297
Iki Sima 339
Ildefonso Islands 298

INDEX TO APPENDIX IV.

PLACES—continued.

Page.
Ilha Grande 297
Ilheos 297
Ilo 301
Iloilo 335
Inaboye Saki 340
Inaccessible Island 303
Inagua Islands 292
Inch Keith Rocks 305
Indefatigable Island 342
Indian, Cape 342
—— Harbor 279
—— Head 353
—— Tickle 279
Indianola 284
Indio Point 298
Indispensable Reefs 346
Indrapura Point 330
Ingolfshofde 357
Ingolsfjeld 356
Inishboffin 306
Inishowen Head 306
Inishrahull 306
Inishturk Island 306
Inіue Island
Innamban Bay 323
Inscription, Cape 351
Investigator Strait 352
Ipswich 282
Iquape 297
Iquique 301
Ireland Island 303
Isaac, Great, Cay 291
Isabel, Cape 299
—— Island 346
—— Point 284
Isabella de Sagua 293
Isene 320
Isidro, San, Cape 299
Isla Grande 291
Island Harbor 288
Islay 301
Isle of Man 305
Isola 317
Isolette, Cape 327
Istria, Cape d' 317
Itacolomi Islet 297
—— Point 296
Itapacaroya Point 297
Itaparica 296
Itapemirim 297
Iturup Island 341
Ivigtuk 356
Iwo Shima 339
Iwo-sima 339

Jabwat Island 343
Jackson, Port 352
Jacksonville 284
Jacmel 294
Jacobshavn 356
Jaffa, Cape 352
Jago, St., Island 303
Jaguaribe River 296
Jaluit Island 343
Jamaica 293
James Island 342
—— St., Cape, C. China 336
—— —— —— Vancouver I. 288
Jan Mayen Island 357
Jara Head 301

Page.
Jarea 315
Jarvis Island 345
Jask Bay 328
Java 331
—— Head 331
Jean, St., de Luz 314
Jebel Zukur Island 325
Jelaka, Pulo 331
Jelalil 324
Jensen Nunatak 356
Jeremie 294
Jershöft 310
Jervis Bay 352
—— Cape 352
—— Island 342
Jesus Maria Island 346
Jiddah 324
Jighinsk Island 356
Johanna Island 326
John, St., Cape, Newf'dl'd. 279
—— —— —— Staten Island 298
—— —— Island 294
Johns, St., Island, Red Sea. 324
—— —— New Brunswick.. 281
—— —— Newfoundland 279
—— —— River 284
Johnston Islands 344
Jolo Islands 336
Jomfruland 308
Jona, St., Island 341
José, San, California 289
—— —— de Guatemala 291
—— —— del Cabo 290
—— —— Port 298
Joseph Henry, Cape 355
Juan Fernandez Island 350
—— San 294
—— —— Cape 294
—— —— del Sur 291
—— —— Point 285
—— —— Port, Peru 301
—— —— —— Vancouver I. 288
—— St., Bay 295
Juanico, San, Point 290
Juby, Cape 321
Jucaro 293
Judith Point 282
Juggernath 329
Juist 312
Julian, San, Port 298
—— St., Island 331
Julianshaab 356
Juneau 288
Jupiter Inlet 284
Jura Island 319
Juul, Cape 356

Kabenda Bay 322
Kabuli Island 334
Kado Sima 341
Kagoshima 340
Kahoolawe Island 344
Kahrig Islet 328
Kaipara Harbor 355
Kais Islet 328
Kajartalik Island 356
Kakirouma 339
Kal Farun Islet 324
Kalboden Island 309
Kalibia 321

Page.
Kalingapatam 329
Kallundborg 312
Kalpeni Islet 325
Kama Islands 343
Kamaishi 340
Kamarán Bay 325
Kambangan Island 331
Kambara Island 348
Kamchatka, Cape 341
Kanala, Port 350
Kanathea Island 348
Kandavu 347
Kandeliusa Island 319
Kangamint 356
Kangarssuk Havn 356
Kannanur 328
Kao Island 350
Kappeln 311
Kara Burnu, Cape 320
Karachi 328
Karafuto 341
Karajinski Island 341
Karimon Djawa Island 332
Karlshamn 309
Karlskrona 309
Kaske 309
Kasm 328
Katakolo Bay 319
Kater Island 345
Katiagam 330
Katic Rock 318
Kauãi Island 344
Kawhia Harbor 354
Keats, Port 351
Kee-lah Island 325
Keeling Islands 327
Keenapoussan Island 336
Keitum 311
Kelantan River 336
Kendall, Cape 355
Kent Island 352
Keppel Island 348
Kermadec Islands 350
Kertch 320
Ketoy Island 341
Key West 284
Khárig Islet 328
Kharim-Kotan Island 341
Kheli 319
Khor Nohud 324
—— Nowarat 324
—— Fakan Bay 327
Ki Islands 332
Kiaochow Bay 338
Kiama Harbor 352
Kidnappers Cape 354
Kiefali, Cape 318
Kiel 311
Kiirun Ko 338
Kikai-jima 339
Kiliman 323
Killiney Hill 307
Killybegs 306
Kilwa Kisiwani 323
Kimbeedso Island 325
King George Sound 351
—— Island, Australia 352
Kings Island 349
Kingston 293
Kingstown 307
Kinkwosan Island 340

PLACES—continued.

Page.
Kinnsund 308
Kino Point 290
Kinsale 307
Kirkwall 305
Kisimayu Bay 324
Kiska Island 287
Kistna 329
Kiswere 324
Kittan Islet 325
Kjorge 312
Knocklane 306
Knockmealdown Mountain 307
Knocknarea 306
Knox Bay 288
—— Cape 288
Knysna 323
Kobe 340
Kodiak Island 288
Koh Chang 336
—— Kong River 336
—— Krah Islet 336
—— Tang Rocks 336
Kokoun-tan Islands 339
Koksher 310
Kolding 312
Komba Island 332
Kompas Mountain 308
Kongelab Islands 343
Konigsberg 310
Koniushi Island 287
Koppern 307
Koroni Anchorage 319
Korror Islands 344
Kos 320
Kosair, Arabia 327
—— Red Sea 324
Kosime No Osima 339
Koster 308
Kottaringin Bay 333
Kovra Rythi Point 326
Kozu Shima Mountain 340
Krakatoa Island 331
Krishna Shoal 329
Kroë 330
Kronberg 312
Kronstadt 310
Krusenstern Cape 287
Kub Kalat 328
Kuchino Shima 339
Kuchinotsu 339
Kuino 310
Kullen Point 308
Kumi Island 338
Kumpta 328
Kunashir Island 341
Kundapur 328
Kunfidah 324
Kuper Harbor 339
—— Port 288
Kuria Maria Islands 327
Kuro Sima 339
Kusakaki Jima 339
Kusrovie Rock 336
Kusterjeh 320
Kutpur 328
Kuweit 327
Kweshan Islands 338
Kyangle Islets 344
Kyuquot Sound 288

Page.
Labuan Island 333
Labyrinth Head 298
La Caloma 293
Laccadive Islands 325
Lacepede Island 351
Lady Elliot Island 353
—— Frances, Port 326
Lagartos 285
Laghi, Cape 318
Lagoon Head 290
Lagos 315
—— River 322
Lagosta Island 318
Lagostini Island 318
Lakemba Island 348
Lamaka 320
Lambayeque 302
Lambert, Cape 351
Lamo Bay 324
Lamock Island 337
Lampedusa Island 317
Lampong Bay 330
Lamyit Island 337
Landfall Island 299
Lands End 304
Landskrona 308
Landsort 309
Langanaes Point 357
Langeland Island 312
Langeoog 312
Langesund 308
Langford, Port 288
Langkuas Island 331
Langotangen 308
Langwarden 311
Lanzarote Island 303
La Paz 290
La Plata 298
Laruehuapi Cove 300
Lassa, Cape 333
Lassau 311
Latakia 320
Latouche Tréville, Cape 351
Laun 279
Laurie Island 304
Laut, Pulo 333
Lavaca 284
Lavata 301
Lawrence, St., Island, Alaska 287
—— —— —— Siberia 342
Laykan, Port 333
Laysan Island 344
Lazaref, Port 339
Lazaro, San, Cape 290
Leander Shoal 280
Leba 310
Lebu River 300
Leeuwin, Cape 351
Legendre Island 351
Leghorn 316
Lema Island 337
Lemnos Island 319
Lengua de Vaca Point 300
Lennox Cove 298
Leones Island 298
Leopold, Port 355
Lepar, Pulo 331
Le Pilier Island 314

Page.
Lepreau Cape 281
Lerma 285
Lerwick 305
Leschenault, Cape 351
Lesina Island 318
L'Etang Harbor 281
Leven Island 326
—— Port 326
—— River 354
L'Evêque, Cape 351
Lewis, St., Cape 279
Leyden 312
Leyte Island 335
Lhou Reef 347
Liakhov Islands 356
Liancourt Rocks 339
Liant, Cape 336
Liao-ti-shan 338
Libau 310
Libertad, C. America 291
—— Mexico 290
Lifu Island 350
Lighthouse Rocks 288
Limerick 306
Limon, Port 286
Lincoln Island 337
—— Port 352
Lindesnes 308
Lindi River 324
Lindo, Port 320
Linga Island 330
Linguelta, Cape 318
Linosa Island 317
Lipari Island 317
Lisbon 315
Lisburne Cape 287
Lisiansky Island 344
Lissa Island 318
List 311
Lister 308
Lith 324
Litkieh Island 343
Little Hope Island 281
Lituya Bay 288
Liverpool 305
—— Port 326
—— River 351
Livorno 316
Lizard Point 304
Llico 300
Loa River 301
Loaf Island 346
Loango Bay 322
Lobito Point 322
Lobos Cay, Bahamas 292
—— —— Mexico 285
—— de Afuera Island 302
—— —— Tierra 302
—— Island, Canaries 303
—— —— Uruguay 298
—— Point, N. Chile 301
—— —— S. Chile 301
Lodingen 307
Lofoten Island 307
Loggerhead Key 284
Loheiyah 325
Loma Point 289
Lomas Point 301
Lombata Island 332

PLACES—continued.

Page.
Lombok Island 332
London, East 323
Londonderry 306
—— Cape 351
Long Island, Bahamas 292
—— —— United States 282
Looké, Port 326
Lookout Cape, N. Carolina 283
—— Point, Australia 353
—— —— Maryland 283
Lopatka, Cape 341
Lopez, Cape 322
Lorenzo, San, Cape 302
—— —— Island 301
Loreto 290
Lorient 314
Loro, Mount 334
Lorstakken Mountain 308
Los, Isles do 321
Lota 300
Lots Wife Rock 340
Lough Larne 306
Louis, Port, Falkland Is. 304
—— —— Guadeloupe 294
—— —— Mauritius Island. 325
——St. 321
Louisburg 281
Louisiade Archipelago 347
Loune 312
Low Island 337
—— Port 300
Lowenorn, Cape 356
Lowestoft 305
Loyalty Islands 350
Lubang Island 334
Lucar, San 315
Lucas, San 290
Lucia, Santa 326
—— St. 293
—— —— Cape 323
—— —— I., C. Verde Is. 303
—— —— —— Windward Is. 295
Lucipara Island 332
Lucipari Islands 331
Lucrecia Point 292
Lucrietta Island 318
Lüis, San, Island 290
Luké Point 341
Lund 308
Lundy Island 304
Lunenburg 281
Lungo 309
Lupona Point 290
Lurio Bay 323
Lussin Piccolo 318
Luzon Island 334
Lyö Island 312

Maasin 335
Macahé 297
Macao 337
MacAskill Islands 343
Macauley Island 350
Maceio 296
Machias 281
—— Island 281
Machikora 326
Mackenzie Islands 343
MacLeay Islets 351
Macquarie Harbor 354
—— Island 350

Page.
Macquarie, Port 352
Macquereau Point 280
Madagascar 323
—— Reef, Africa 323
—— —— Yucatan 285
Madame Island 281
Madanas Point 298
Madeira Island 303
Madras 329
Madryn, Port 298
Madura Island 331
Maestro de Campo Island.. 335
Mafamale Island 323
Mafia Island 324
Magadoxa 324
Magdalen Cape 280
—— Islands 280
Magdalena Bay 290
—— River 295
Magnetic Pole 355
Magoari Cape 296
Mah Kundu Island 325
Mahanuru 326
Mahé 328
Mahia Peninsula 354
Mahon, Port 316
Maiana Island 342
Maiden Rocks 306
Mairaira Point 334
Máit Island 324
Maitea Island 349
Maitencillo Cove 300
Majamba Bay 326
Majorca 316
Majunga 326
Majuro Islands 343
Makalleh Bay 327
Makarska 318
Makassar 333
Makatea Island 349
Makaua Island 324
Makemo Island 349
Makers Ledge, South 280
Makkian Island (Makjan I.). 333
Makongai Island 348
Makry 320
Mala Cape 291
Malabrigo Bay 301
Malaga 315
Malaita Island 346
Malakka 330
Malamocco 317
Malaspina, Port 298
Malden Island 345
Maldonado, Mexico 291
—— Uruguay 298
Malé Island 325
Malemba Bay 322
Malin Head 306
Mallicollo Island 347
Malmö 308
Malo, St. 313
Maloclab Islands 343
Maloren 309
Malpelo Island, Galapagos.. 342
—— —— Panama 291
Malpeque Bay 280
Malta 317
Mamuka Island 348
Manaar 329
Mana Sima 340

Page.
Manado Bay 333
Manao 340
Mana-watu River 354
Manda Roads 324
Mandarins Cap 337
Mandavi 328
Manfredonia 317
Mangaia Island 350
Mangalore 328
Mangaratiba 297
Mangareva Island 349
Mangarin Point 334
Mangarol 328
Mangles Point 302
Mango Island 348
Manila 334
Mano Island, Asia 332
—— —— Denmark 312
Manoel, Cape 321
Manroux I. 294
Manta Bay 302
Manua Island 348
Manukau Harbor 355
Manvers, Port 279
Manzanillo, Cuba 293
Manzanillo Bay, Mexico.... 291
—— Point, Haiti 293
Maracaibo 295
Maraki Island 342
Marambaya Island 297
Maranhão Island 296
Marble Island 355
Marblehead 282
Marcial, San, Point 290
Marcos, San, Island 290
Marcus Island 344
Mare Harbor 304
—— Island, California 289
—— —— S. Pacific 350
Maret Islets 351
Margaret Bay 281
Margate Head 322
Maria Island 349
—— Madre Island 291
—— Port 293
—— Sta., Cape, Portugal.. 315
—— —— —— Uruguay ... 298
—— —— Cove 290
—— —— di Leuca, Cape... 317
—— —— Island, Azores.... 302
—— —— —— Chile 300
—— —— —— S. Pacific.... 347
—— —— Port 335
Marianas 344
Maricas Islands 297
Marie Galante 294
Marienleuchte 311
Mariguana Island 292
Marinduque Island 335
Marion Island 327
Maripipi Island 335
Maritimo Island 317
Marjes Islets 295
Marjoribanks 339
Marks, St. 284
Marlborough Island 342
Marmora Island 320
Marmorice 320
Maro Reef 344
Maroni River 296

PLACES—continued.

Page.
Marsala ... 317
Marseilles ... 316
Marshall ... 322
—— Islands ... 343
Marstenen Islet ... 308
Marta, Sta ... 295
Martha, St., Cape ... 297
Martin de la Arena, San ... 314
—— Garcia Island ... 298
—— San, Island, L. Cal ... 290
—— St., I., Leeward Is ... 294
—— Vaz Rocks ... 303
Martinique ... 294
Martires, Los ... 343
Marua Island ... 349
Marutea Island ... 349
Mary Island ... 345
—— St., Bay ... 322
—— —— Cape, Madagascar. 326
—— —— —— Newfoundland ... 279
—— —— —— Nova Scotia. 281
—— —— Reefs ... 280
Marys, St., Island ... 326
Marzo Cape ... 302
Mas Afuera Island ... 350
Masbate Island ... 335
Masinloc ... 334
Masirah Island ... 327
Maskat ... 327
Massaua Harbor ... 324
Masset Harbor ... 288
Masulipatam ... 329
Matabella Islands ... 332
Matacong Island ... 321
Matagorda ... 284
Matahiva Island ... 349
Matamoras Cove ... 300
Matana Island ... 341
Matanzas Peak ... 293
Matatane ... 326
Matelotas Islands ... 343
Matema Islands ... 347
Maternillos Point ... 292
Matinicus Rock ... 281
Matoya ... 340
Matthew Island ... 347
—— St., Island, Alaska ... 287
—— —— —— Burma ... 329
—— —— —— Siberia ... 342
Matthias, St., Island ... 346
Matu Sima ... 339
Matuku Island ... 348
Mauger Cay ... 285
Maui Island ... 344
Mauki Island ... 350
Maunganui Harbor ... 354
Maupili Island ... 349
Mauritius ... 325
May, Cape ... 283
—— Island ... 305
Mayaguez ... 294
Mayé Mountain ... 296
Mayne Harbor ... 299
—— Mountain ... 300
Mayo Island ... 303
Mayotta Island ... 326
Maysi Cape ... 292
Mayumba Bay ... 322
Mazarron ... 315

Page.
Mazatlan ... 291
Mazemba River ... 323
Mbega Island ... 348
Mchinga Bay ... 324
McKean Island ... 345
Mecate Mountain ... 285
Mednoi Island ... 341
Mega Island ... 330
Megalo Kastron ... 319
Mehediah ... 321
Meiaco Sima ... 338
Meiaco-sima Islands ... 339
Mejia Island ... 290
Mekattina Islands ... 280
Mel, Ilha do ... 297
Melbourne ... 352
Meleda Island ... 318
Melinda ... 324
Melle, Cape ... 316
Mellish Reef ... 347
Melmore Head ... 306
Melo, Port ... 298
Melville, Cape, Balábac I ... 333
—— —— Queensland ... 353
—— Island, Australia ... 351
—— —— Barrows Strait ... 355
—— —— Tuamotu Arch ... 349
Memel ... 310
Memory Rock ... 292
Menali Island ... 330
Menchikof Cape ... 287
Mendocino Cape ... 289
Mendoza Island ... 337
Merbat ... 327
Mercy Harbor ... 299
Mergui ... 329
Mesa de Doña Maria ... 301
Messina ... 317
Mesurado, Cape ... 322
Meurka ... 323
Mew Islands ... 306
Mewstone Rock ... 354
Mexican Boundary ... 289
Mexico, City of ... 285
Mexillon Bay ... 301
Mexillones Mountain ... 301
Mezen ... 356
Miautao Island ... 338
Michael, St., Fort ... 287
—— —— Island ... 302
Michaeloff Island ... 348
Middleton Island ... 288
Midway Islands ... 344
Miguel, San, Island ... 289
—— —— Islands ... 336
Mikake Jima ... 340
Mikindini ... 324
Mikomoto Island ... 340
Mikura Jima ... 340
Milagro Cove ... 300
Milazzo ... 317
Mile Island ... 355
Milford Sound ... 355
Milo Island ... 319
Min River ... 337
Mina Bay, El ... 322
Minchinmadiva Mountain ... 300
Mindanao Island ... 335
Mindoro Island ... 334
Mine Head ... 307

Page.
Minerva Reefs ... 350
Minikoi Island ... 325
Mino Sima ... 341
Minorca ... 316
Minots Ledge ... 282
Minow ... 326
Minsener Sand ... 311
Mintok ... 331
Miramichi Bay ... 280
Misamis ... 336
Miscou Island ... 280
Miskito Cays ... 286
Mississippi River, mouth ... 284
—— City ... 284
Misteriosa Bank ... 286
Mita Point ... 291
Mitchells Island ... 345
Mitho ... 336
Mitiero Island ... 350
Mitre Island ... 347
Mityleni Island ... 319
Mizen Hill ... 306
Moa Cayo, Port ... 292
—— Island ... 332
Moala Island ... 348
Mobile ... 284
Mocha Island ... 300
Mocomoco Point ... 296
Modeste Island ... 339
Moeara Kompehi ... 330
Moen Island ... 312
Moerenhout Island ... 349
Mogador ... 321
Mohilla Island ... 326
Mojanga ...
Mokambo, Port ... 323
Mokatein ... 327
Mokha ... 325
Mokil Islands ... 343
Molle, Port ... 353
Mollendo, Port ... 301
Moller Port ... 287
Molloy ... 327
Molokai Islands ... 344
Molonta Peninsula ... 318
Moluk Island ... 325
Molukka Islands ... 338
Molyneux Bay ... 355
—— Sound ... 299
Mombasa ... 324
Mona Island ... 294
Monastir ... 321
Mondego, Cape ... 315
Monfalcone ... 317
Monhegan Island ... 281
Monomoy Point ... 282
Monrovia ... 322
Montagu Island ... 352
Montalivet Islands ... 351
Montauk Point ... 282
Monte Christo Islet ... 316
Monte Cristi ... 293
Montebello Island ... 351
Montego Bay ... 293
Montepio ... 285
Monterey ... 289
Monteverde Islands ... 343
Montevideo ... 298
Montravel Island ... 339
Montreal ... 280
Monts, Point de ... 280

PLACES—continued.

Page.
Montserrat 249
Montt, Port 300
Monze, Cape 328
Mopelia Island 348
Morane Island 349
Morant Cays 293
—— Point 293
Morayva 315
Morecambe Bay 305
Moreno Mountain 301
Moresby, Port 346
Moreton, Cape 353
Morgan, Cape 323
Morjovetz Island 356
Morlaix 313
Morotiri Islands 350
Morris Jesup, Cape 356
Morro Ayuca 291
—— de São Paulo 296
—— Petatlan 291
—— Solar 301
Mortlock Islands 343
Mota, Point 293
Motane Island 345
Mothe Island 348
Mothoni 319
Motu-ili Island 345
Motu-iti Island 349
Moudros 319
Moukon rushi Island 341
Moulmein 329
—— River 329
Mount, Cape 322
Mourondava 326
Moville 306
Mozambique 323
Msimbati 324
Mugan Mwania 324
Mugeres Island 285
Muilcalpue Cove 300
Mukulaelae Island 345
Muleje 290
Mulu Island 332
Mura Harbor 340
Murat Hill 324
Murderers Bay 326
Murdock Point 353
Murundum Island 337
Mururoa Island 349
Muscat 327
Musendum, Ras 327
Mussel Bay 299
Mysole Island 332

Nachvack Bay 279
Nafa-Kiang 339
Nagai Island 287
Nagasaki 339
Naian Island 348
Nain 279
Nairn Cay 292
Naitamba Island 348
Naka no Shima 339
Nakkehooed 312
Nam-Dinh 336
Namki, Port 338
Namoluk Islands 343
Namonuito Islands 343
Nam-quan 337

Page.
Namu Island 343
Nanaimo 288
Nancowry Harbor 330
Nanka Island 331
Nanomea Island 345
Nanoose Harbor 288
Nansei Shoto 339
Nantes 314
Nantucket Island 282
—— Shoals 282
Naples 317
Napuka Island 349
Nar Foree Island 325
Naranjo, Port 292
Narendri Bay 326
Nargen Island 310
Narva 310
Nasca Point 301
Nasparti Inlet 288
Nassau 292
Natal, Brazil 296
—— Port, Africa 323
—— Sumatra 330
Natashquan Point 280
Natuna Islands 331, 337
Naturaliste, Cape 351
Nauomaga Island 345
Navachista 291
Navalo, Port 314
Navarin 319
—— Cape 341
Navassa Island 294
Navesink Highlands 283
Navidad Bank 292
—— Bay 291
Navire Bay 327
Naxos Island 319
Nazaire, St., Port 314
Necker Island 344
Needles Rocks 304
Negapatam 329
Negrais, Cape 329
Negro, Rio 298
Negros Island 335
Neill, Port 355
Nelson 355
—— Cape 352
—— Port 351
Nemuro 341
Neptune Isles 352
Nera Point 317
Netherland Island 345
Neunortalik 356
Neuwerk 311
Nevil Island 344
Neville, Port 288
Nevis 294
New Bank 285
—— Bedford 282
—— Britain 346
—— Caledonia 350
—— Guinea 346
—— Hanover 346
—— Haven 282
—— Hebrides 347
—— Ireland 346
—— London 282
—— Mecklenburg 346
—— Orleans 284
—— Plymouth 354

Page.
New Pommern 346
—— South Orkneys 304
—— —— Shetland 304
—— Westminster 289
—— York 283
Newbern 283
Newburyport 282
Newcastle 352
Newchwang 338
Newfoundland 279
Newport, Ireland 306
—— Rhode Island 282
Newton Head, Great 307
Nezumi Jima 339
Ngatik Islands 343
Ngau Island 348
Nias Island 330
Nice 316
Nicholas, St., Island 303
Nicholson, Port 354
Nickerie River 296
Nicobar, Great, Island 330
—— Islands 330
—— San, Island 289
Nidingen Islet 308
Nieuport 313
Niewe Diep 313
Nihiru Island 349
Niigata 340
Nikalao, St., Island 319
Nikolaevsk 341
Nikolaia, St., Cape 341
Nikolaieff 320
Nikolo, St., Port 319
Nila Island 332
Nile River 320
Nimrod Sound 338
Nine-pin Rock 337
Ning-po 338
Nipe Bay 292
Niquero 293
Nitendi Island 347
Niua-fu 348
Niue Island 348
Niutao Island 345
No Sima Saki 340
Noir Island 299
Noir Moutier Island 314
Nolloth, Port 323
Nome Cape 287
Nonuti Island 342
Nootka Sound 288
Nord Koster Islands 308
Norderney 312
Norfolk 283
—— Island 350
Norman Cape 280
Norrkopings Inlopp 309
Norrsher Islet 309
Norrtelge 309
North Cape, Arctic Amer 355
—— —— Brazil 296
—— —— C. Breton I 281
—— —— Iceland 357
—— —— New Zealand 354
—— —— Norway 307
—— Harbor 288
—— Island, Vancouver 288
—— —— Volcano Islands 345
—— Lord, Island 344

PLACES—continued.

Page.
North Standing Creek 286
Northumberland, Cape 352
—— Isles 353
Northwest Cape 351
Norwalk Island 283
Noshiaf Misaki 341
—— Saki 341
Nosi Bé 326
Nossa Senhora do Deserto 297
Notch Cape 299
Notsuke 341
Nottingham Island 279
Noumea 350
Noun, Cape 321
Nouvelle, Port 316
Nova Zembla 356
Novogorod, Port 341
Nuevitas, Port 292
Nuevo, Port 291
Nugget Point 355
Nui Island 345
Nuistad 309
Nuka-Hivi 345
Nukufetau Island 345
Nukunau Island 342
Nuku-nono 345
Nukuor Islands 343
Nukutavake Island 349
Nukutipipi Island 349
Numba Island 323
Nunez River 321
Nunivak Island 287
Nurse Channel Cay 292
Nuyts Point 351
Ny Sukkertop 356
Nyborg 312
Nykjobing 312

Oahu 344
Oatafu Island 345
Oban 305
Obi Islands 336
Obi Major Island 332
Obispo Shoal 285
Obristadbroekke 308
Observation Island 339
Occasional Harbor 279
Ocean Island, N. Pacific 344
—— —— S. Pacific 346
Ockseu Island 337
Ocracoke 283
Oddensby 312
Odenskholm 310
Odessa 320
Odia Islands 343
Oeno Island 349
Offer Wadham 279
Ogasawara Islands 345
Oho-sima 339
Okayama, Port 340
Okhotsk 341
Oki Islands 341
Okishi Bay 341
Okso 308
Oland Island 308
Old Fort Island 280
—— Point Comfort 283
—— Providence 286
Olcai Islands 343
Oleron Island 314

Page.
Olga, Port 341
Olimarao Islet 343
Olinda 296
Olipa Rock 318
Oliutorski, Cape 341
Olivença 297
Omapui Island 336
Omenak Island 356
Omo Island 312
Omoa 286
Omoi Saki 340
One Fathom Bank 329
Oneata Island 348
Onega 356
Ongea Levu Island 348
Ono Islands 348
Onoatoa Islands 342
Oō-Sima Harbor 340
Oparo Island 350
Opobo River 322
Oporto 314
Oraluk Island 343
Oran 321
Orange Cape, Brazil 296
—— —— Magellan Strait 299
Oranienbaum 310
Orchila Island 295
Oregrund 309
Orfordness 305
Orizaba Mountain 285
Orkney Islands 305
Ormarah 328
Ormoc 335
Ornbay Island 332
Oro No Sima 339
Oropesa Cape 315
Orskar Rock 309
Oruba Island 295
Osaka 340
Osaki Bay 340
Oscarsberg 308
Osnabrug 349
Ostend 313
Osthammar 309
Ostro Point 318
Otago Harbor 355
Otranto, Cape and Port 317
Ottawa 280
Otway, Cape 352
—— Port 299
Oune-Kotan Island 341
Ouro River 321
Ovalau Island 347
Owashi Bay 340
Oxford 304
Oxhoft 310

Paanopa Island 346
Pabellon de Pica 301
Pacasmayo 301
Padang 330
—— Tikar 333
Padaran, Cape 336
Padre, Port 292
Pagan Island 344
Pagonia, Port 319
Paimboeuf 314
Paix, Port 294
Pajaros Islets 300
Pak Chan River 329

Page.
Pakhoi 337
Pakonjidol Rock 318
Palamos Bay 315
Palanog 335
Paláwan Island 333
Palembang 330
Palenita 291
Palermo 317
—— Port 318
Pali, Cape 318
Pallas Rocks 339
Palliser, Cape 354
Palm Islands 353
Palma Island 303
Palmas Bay 297
—— Cape 322
—— Point 285
Palmerston, Cape 353
—— Islands 348
Palmyra Island 342
Palompon 335
Palos Bay 333
Pamaroong Island 333
Pamban Pass 328
Pampatar Island 295
Pan de Azucar Island 300
Panama 291
Panay Island 335
Pangituran 336
Panjang Island 336
Pank Piah Rock 337
Pantar Island 332
Papey Island 357
Paposo Road 301
Para 296
Paraca Bay 301
Paracel Islands 337
Parahiba River and Port 296
Paramaribo 296
Paranagua 297
Paranahiba River 296
Paraoa Island 349
Parati 297
Paredon Grande Cay 292
Parenga-renga 354
Parenzo 317
Parga 319
Parida 291
Parinas Point 302
Paris 313
Parker Cape 299
Paros Island 319
Parry Island 350
Parrys Group 345
Pasado Cape 302
Pasages, Port 314
Pascagoula, East 284
Pasni 328
Passaro, Cape 317
Pasuruan 331
Patache Point 301
Patani, Tanjong 336
Paternoster Rocks 308
Paterson Inlet 355
Pato Island 296
Patuca River 286
Patos Island 290
Patras 319
Patrick, St., Head 354
Patterson, Port 351

PLACES—continued.

Page.

Paul, St., de Loando 322
—— —— Island, N. Amer. 281
—— —— —— Tuamotu 349
—— —— Réunion Island 326
—— —— Rocks 303
Pauls, St., Island 327
Paxo Island 319
Paypoton Mountain 285
Pearce Point 351
Pearl and Hermes Reef 344
—— Cays 286
Pedra Blanca Rock 337
—— Branca 330
—— de Galha 321
Pedro Bank 293
—— San 290
—— —— Point 301
—— —— Port 300
Peel 351
—— Island 345
Pegasus, Port 355
Pei Ho 338
Pekalongan 331
Pelado Island 301
Pelagosa Rock 318
Peloro, Cape 317
Pemba Bay 323
Pembroke Cape 304
Pena Point 296
Penang, Pulo 329
Peñas Anchorage 291
Pendulum Islands 356
Penguin Islands 327
Penha Grande 321
Peniche 315
Penmarch Rocks 314
Penrhyn Island 345
Pensacola 284
Pentland Skerries 305
Percy Isles 353
Perim Island, Africa 324
—— —— India 328
Pernambuco 296
Pernau 310
Peros Banhos Islands 325
Perth 351
Peru Island 342
Perula Bay 291
Pescadores Islands, Asia, E. coast 338
—— —— N. Pacific 343
—— —— Peru 301
—— Point 301
Pe-shan Islands 338
Petali Island 319
Petalidi Bay 319
Peter, St., Port 313
Peterhof 310
Petersburg, St 310
Petersdorf 311
Petit Manan Island 281
Petite Terre 294
Petropavlovsk 341
Petropolis 297
Pha-li-du Island 325
Philadelphia 283
Philip Island 343
Philipp Broke, Cape 356
Philips Point 290
Phillip, Port 352

Page.

Phillips Island 349
Phoenix Island 345
Pi 316
Pianosa Island 316
Pichidanqui 300
Pichilinque Bay 290
Pico Island 302
Pictou Harbor 281
Piedra Blanca 336
Piedras Blancas 289
—— Cay, Cuba, N. coast 293
—— —— —— S. coast 293
—— Point 298
Pieman River 354
Pierre, St., Newf'dl'd 280
—— —— Réunion I 326
—— —— Rock 331
Pietro di Nembo, St., Island 318
Pigeon Point 289
Pih-ki-shan Island 338
Pih-quan Peak 338
Pih-seang Island 337
Pikelot Island 343
Pililu Island 344
Pillau 310
Pillar, Cape, Chile 299
—— —— Tasmania 354
Pinaki Island 349
Pine, Cape 279
Pingelasp Islands 343
Ping-fong Island 337
Ping-hai Harbor 339
Pinnacle Islet 287
Pinos, Isla de 293
Pinos Point 289
Pique Bay 341
Piraeus 319
Pirano 317
Pisagua 301
Pisang 330
Pisco 301
Pitcairn Island 349
Pitea 309
Pitong Island 330
Pitre Point 294
Placentia Harbor 279
—— Point 286
Pladda Island 305
Plana Cay 292
Planier Rock 316
Plata, Isle 302
Platte Island 325
Playa Colorado 291
—— Maria, La 290
—— Parda Cove 299
Pleasant Island 346
Plettenburg Bay 323
Plum Island 282
Plymouth, England 304
—— U. S 282
Poile, La, Bay 280
Pola 317
—— Sta., Bay 315
Polillo Island 335
Pollard Cove 299
Polloc 335
Polusuk Island 343
Pomo Rock 318
Ponafidin Island 340
Ponapi Island 343

Page.

Pond Mountain 290
Pondicherri 329
Ponga River 321
Ponza Islet 317
Poolbeg 307
Popa Island 332
Popof Island 287
Porcos Grande Islet 297
Porbandar 328
Porman 315
Poro musir Island 341
Poros Island 319
Port au Prince 294
—— Montt 300
—— of Spain 296
—— Plata 293
—— Royal, Jamaica 293
—— —— S. Carolina 283
—— Said 320
Portendik 321
Porthcurnow 304
Portland, Bay 352
—— Cape 354
—— England 304
—— Maine 282
Porto Bello 287
—— Ré 317
—— Rico 294
—— Santo 303
—— Seguro 297
—— Vecchio 316
Portsmouth, England 304
—— U. S 282
Possession, Cape 299
—— Island 327
Postilion Islands 332
Povorotnyi, Cape 341
Prado 297
Pratas Island 337
Premeira Islands 323
Preservation Inlet 355
Prestenizza Point 317
Prevesa 319
Pribilof Islands 287
Prince Edward Island 280
—— Edwards Islands 327
Prince of Wales Cape 287
—— —— —— Island 353
—— —— —— Sound 279
—— Regent River 351
—— Rupert Hbr 288
Princes Island 322
Proeste 312
Progreso 285
Promontore Point 317
Proti Passage 319
Proven 356
Providence 282
—— Island 343
—— Port 342
Psara Island 319
Pucio Point 335
Puerto Cabello 295
—— Mexico 285
—— Santo Bay 295
Puka-puka Island 349
Puka-ruha Island 349
Pulicat 329
Pulkowa 310
Pulpito Point 290

PLACES—continued.

Page.
Puna 302
Purdy Island 346
Putziger Heisternest 310
Pyramid Point 337
Pyramidal Rocks 331

Quaco, Cape 281
Quaebo River 322
Quebec 280
Queen Charlotte Island 349
Queenstown, Ireland 307
—— N. Zealand 355
Quelpart Island 339
Quemada Grande Island 297
Quentin, San, Port 290
Querimba Islands 323
Queule Bay 300
Quilan, Cape 300
Quilca 301
Quilon 328
Quin Hon 336
Quiniluban Islet 334
Quintero Point 300
Quita Sueño Bank 286
Quod, Cape 299
Quoddy Head 281
Quoin Great, Island 327
—— Point 323

Race, Cape 279
—— Island 288
Rachado, Cape 330
Radakala Islands 343
Radama Islands 326
—— Port 326
Ragged Island 292
Ragusa Rocks, Pettini di 318
Rakkin, Ras 327
Raleigh Rock, China 337
—— —— Formosa 338
Ramas, Cape 328
Rame Head 323
Ramree Island 329
Rangiroa Island 349
Rangoon 329
—— River 329
Ranu Cove 300
Raoul Island ...
Rapa Island 350
Raper Cape 299
Raphti, Port 319
Rarotonga Island 350
Rasa Island 345
Rathlin Island 306
—— O'Birne Island 306
Ratnagherry 328
Ravahere Island 349
Ravn Storo 356
Rawean Island 332
Ray Cape 280
Raza Island, Brazil 297
—— —— C. Verde Is 303
—— —— L. California 290
Razzoli Island 316
Ré Island 314
Real River 296
Reao Island 349
Recherche Archipelago 352
Recife Cape 323
Red Islet 351

Page.
Redang, Great, Harbor 336
Redfield Rocks 340
Redonda Islet 294
Redondo Rock 342
Reirson Island 345
Reitoru 349
Rembang 331
Remedios Bay 290
Renard Island 347
—— Islands 347
Rennel Island 346
Rensher 309
Repon, Pulo 331
Resolution Island 279
Reunion Island 326
Revel 310
Rey Island 291
Reyes Head 301
—— Point 289
Reykianaes 357
Reykiavik 357
Reythur Fjeld 357
Rhio 330
Rhodes, Port 320
Rhynns of Islay 305
Ribnitz 311
Rich Point 280
Richmond 283
—— River 353
Riga 310
Rigny Mount 356
Rimitara Island 350
Ringkjobin 312
Rio Grande del Norte 284
—— —— do Norte 296
—— —— —— Sul 297
—— Janeiro 297
Riofrio, Port 299
Risiri Islet 341
Rissnaes Point 357
Rivadeo 314
Rivadesella 314
Rivers, Cape 333
Rixhoft 310
Roa Poua Island 345
Roatan 286
Roberts Point 289
Roca, Cape 315
—— Partida, Mexico, E. coast 285
—— —— W. coast 291
Rocas Reef 303
Rochefort 314
Rochelle 314
Rockabill 307
Rockall Islet 302
Rockingham Bay 353
Rockland 281
Rodd Bay 353
Rodkallen 309
Rodney, Cape 346
Rodoni, Cape 318
Rodriguez Island 325
Rodsher Island 309
Roeskilde 312
Rogosnizza 318
Rokugo, Cape 340
Rokuren Island 340
Roma Island 332
Romain, Cape 283

Page.
Roman, San, Cape 295
Romanzof Cape 287
Romanzov Islands 343
Romblon Island 335
Rome 316
Ronaldsay, North 305
Roncador Cay 286
Rongerik Islands 343
Roodewal Bay 323
Roque, St., Cape 296
Roques Islands 295
Rosa, Sta., Island 289
Rosalia, Sta., Bay 290
Rosalind Bank 286
Rosario Island 345
Rose Island 348
—— Spit Point 288
Rosemary Island 351
Rosier Cape 280
Ross Island 339
Rossel Island 347
Rostock 311
Rota Island 344
Rotterdam 313
Rotti Island 332
Rottnest Island 351
Rotumah Island 347
Round Island 338
Roundhill Island 279
Rovigno 317
Roxo Cape 285
Royal Island 292
Royalist, Port 333
Ruad Island 320
Rugenwalde 310
Rum Cay 292
Runaway, Cape 354
Runo Island 310
Rupert Island 299
Rurutu Island 350
Ryvingen Island 308
Ryojun Ko 338

Saba 294
Sabine Pass 284
Sabioncello Peninsula 318
Sablayan Point 334
Sable Cape 281
—— Island 281
Sacatula River 291
Sacrificios Island 285
—— Point 291
Saddle Group 338
—— Island 279
Sado Island 340
Safajah Island 324
Safatu Island 337
Sagua, Isabello de ...
Saida 320
Saigon 336
Saintes Islands 294
Saipan Island 344
Sakai 340
Sakhalin Island 341
Sakishima Gunto 338
Sakonnet Point 282
Sal Cay 293
—— Island 303
Sala y Gomez 350
Salado Bay 300

PLACES—continued.

Page.
Salayar Island 333
Saldanha Bay 323
Salem 282
Sali 321
Salina Cruz 291
Salinas Bay, C. America 291
—— —— L. California 290
—— Point 294
Salisbury Island 279
Salomague Island 334
Salonika 319
Salovetski 356
Saltee, Great 307
Salut Islands 296
Salvador, San 292
Salvage Islands 303
Salvore Point 317
Sama, Port and Peak 292
Samana 293
—— Cay 292
Samanco Bay 301
Samar Island 335
Samarang 331
Sambro Island 281
Samoa Islands
Samos Island 320
Sampit Bay 333
Samso Island 312
Samsoe Island 312
San Blas, Gulf 287
Sand Island 284
—— Key 284
Sandakan Harbor 333
Sandalo, Cape 316
Sandalwood Island 332
Sandfly Cay 286
Sandhammaren 309
Sandwich Island 347
—— Islands 304
Sandy Cape 353
—— Hook 283
—— Point 299
Sangwin River 322
Sanibel Island 284
Sankaty Head 282
Sannakh Island 287
Santa Cruz del Sur 293
Santander 314
—— River 285
Santiago Cape 299
—— de Chile 300
—— —— Cuba 293
—— Port 334
Santo Domingo City 294
Santona 314
Santos 297
Sao João da Barra 297
Saona Island 294
Sapelo Island 283
Saranguni Islands 335
Sarawak 333
—— River 333
Sariguan Island 344
Sarstoon River 286
Saru Island 332
Saseno Island 319
Satano Misaki 340
Satawal Island 343
Saugor Island 329
Sauguir Island 333

Page.
Sauh, Pulo 330
Saukhoum 320
Saunders, Port 280
Sauo Bay 338
Savage Island 348
Savaii Island 348
Savanilla 295
Savannah 283
Savanna-la-Mar 293
Saybrook 282
Scalp Mountain 306
Scarcies River 321
Scatari Island 281
Schama Mountain 301
Schanck, Cape 352
Schanz Island 343
Scharhorn 311
Scheveningen 313
Schillighorn 311
Schleimunde 311
Schleswig 311
Schonberg 311
Scilly Islands, England 304
—— —— S. Pacific 348
Scott Cape 288
Scutari 320
Sea Bear Bay 298
—— Rock 339
Seal Cays 286
—— Island 281
Seao Island 333
Seattle 289
Sebastian, San, Cape, M'g'sc'r 326
—— —— —— Spain 314
—— St., Cape, S. Africa 323
—— —— Island 297
Sebastopol 320
Sebenico 319
Sedano, Cape 331
Sedashigar Bay 328
Seguin Island 281
Sein, I. de 314
Sejro Island 312
Selatan Point 333
Seldom-come-by Harbor 279
Semeny River 318
Semerara Island 334
Semiamoo Bay 289
Semione Island 331
Sentinel Island 339
Serles Island 349
Sermata Island 332
Sermelik Fjord 356
Sermo Island 319
Serrana Bank 286
Serranilla Bank 286
Seskar Islet 310
Setubal 315
Seuheli Par 325
Seven Heads 307
Seychelles 325
Sfax 321
Shag Rocks 304
Shahah 327
Shahr, Abu 328
Shaikh Shu'aib Islet 328
Shaluitien Island 338
Shanghai 338
Shannon River 306
Shantar Islands 341

Page.
Shantung 338
Sharjah 327
Shark Island 346
Sharmoh 327
Shaweishan Island 338
Shelburne Harbor 281
Shelter Bay 341
Shepherd Island 287
Sherbedat, Ras 327
Sherbro Island 322
—— River 322
Sherm Hassey 324
—— Joobbah 324
—— Rabegh 324
—— Wej 324
—— Yahar 324
Shetland Islands 305
Shiash-Kotan Island 341
Shields, North 305
Shimizu Bay 340
Shimonoseki Strait 340
Shinnecock Bay 283
Ship Island 284
—— Shoal 284
Shipunski, Cape 341
Shirasu Reef 340
Shoals, Isles of 282
Shoalwater Cape 289
—— Island 331
Siargao Island 335
Siassi 336
Siberoet Island 330
Siboga 330
Sibuco Bay 335
Sibutu Island 336
Sibuyan Island 335
Sidmouth, Cape 353
Sierra Leone 322
Sighajik 320
Sigri, Port 319
Sihuatanejo Point 291
Sihut 327
Silan 285
Silaqui Islet 334
Silver Bank 292
Simaloe Island 330
Simeonof Island 287
Simoda 340
Simon, St., Island 283
Simonoff Island 348
Simonor Island 336
Simons Bay 323
Simpson, Port 288
Simusir Island 341
Singapore 330
Singkel Island 330
Singkep Island 330
Single Island 337
Singora (Sungkla) 336
Sinon 322
Sinope 320
Siphano Island 319
Siquijor Island 335
Sirik, Cape 333
Siriya Saki 340
Sisal 285
Sitka 288
Sittee Point 286
Skagataas Point 357
Skagi, Cape 357

PLACES—continued.

Page.

Skags Head........ 309
Skaw, Cape........ 312
Skelligs Rocks........ 306
Skerries Rocks........ 305
Skerryvore Rocks........ 305
Skiathos Island........ 319
Skidegate Bay........ 288
Skoorgaarde........ 311
Skumbi River........ 318
Skyring Mountain........ 298
Sligo Bay........ 306
Slyne Head........ 306
Smalls Rocks........ 304
Smerwick........ 306
Smith Island, Japan........ 340
—— —— Washington........ 289
Smyrna........ 320
Snaefells Yokul........ 357
Snares Islands........ 355
Socorro Island, Chile........ 300
—— —— Mexico........ 291
Soder Skars........ 309
Soderarm........ 309
Soderhamm........ 309
Sofala........ 323
Sohar........ 327
Sokotra Island........ 324
Sola Island........ 295
Solander Islands........ 355
Solitary Islands........ 352
Solombo, Great, Island........ 332
Solomon Islands........ 346
Solta Island........ 318
Sombrero........ 294
—— Key........ 284
—— Rock........ 336
Sommer Island........ 310
Song-yui Point........ 337
Sonserol Island........ 344
Soo Bay........ 338
Sorelle Rocks........ 318
Sorol Island........ 343
Sorrel Rock........ 337
Sorrell, Cape........ 354
—— Port........ 354
Sorsogon, Port........ 335
Soumshu Island........ 341
Souwaroff Island........ 348
South Cape, Formosa........ 338
—— —— N. Guinea........ 346
—— Rock........ 306
—— Water Cay........ 286
Southampton........ 304
Southsea Castle........ 304
Southwest Cape........ 354
—— Reef........ 284
Spalato Passage........ 318
—— Port........ 318
Sparo Vestervik........ 309
Spartel, Cape........ 321
Spartivento Cape, Italy........ 317
—— —— Sardinia........ 316
Spencer, Cape........ 352
Spezzia........ 316
Spikeroog........ 312
Spiridione, St., Port........ 319
Spitzbergen........ 356
Spodsbjerg........ 312
Spurn Head........ 305
Square Handherchief Bank. 292

Page.

Staabierg Huk........ 357
Stack, South........ 304
Stade........ 311
Stag Rocks........ 307
Stamp Harbor........ 288
Stampali Island........ 319
Stanley, Port........ 304
Starbuck Island........ 345
Start Point........ 304
Startpoint........ 305
Staten Island........ 298
Staunton Island........ 338
Stavanger........ 308
Steilacoom........ 289
Steinkirchen........ 311
Stemshesten........ 308
Stensher Rock........ 310
Stephens, Port........ 352
Stettin........ 310
Stewart, Cape........ 351
Stewart Islands........ 346
Stirrup Cays........ 292
Stirsudden........ 310
Stockholm........ 309
Stonington........ 282
Stopelmünde........ 310
Stora........ 321
Stornoway........ 305
Stot........ 307
Stralsund........ 311
Strati Island........ 319
Straumness Point........ 357
Streaker Bay........ 352
Streckelsberg........ 311
Strogonof Cape........ 288
Strömstad........ 308
Stromtangen........ 308
Strong Island........ 343
Strovathi Island........ 319
Stuart Island........ 287
Suakin........ 324
Sual........ 334
Subic........ 334
Succadana........ 333
Suda, Port........ 319
Sueik........ 327
Suez........ 324
Suffren, Cape........ 341
Sugar Loaf Point........ 352
Sughrah........ 327
Suk Island........ 343
Sula Islands........ 332
Sulphur Island........ 345
Sumbawa Island........ 332
Sumburgh Head........ 305
Sunda Strait........ 331
Sunday Island........ 350
Sunderland........ 305
Sundsvall........ 309
Sunmiyani........ 328
Supé........ 301
Sur........ 320
Surabaya........ 331
Surat........ 328
—— River........ 328
Surigao........ 335
Surop........ 310
Susaki........ 340
Suwanose Jima........ 339
Suwarrow Island........ 348

Page.

Svalferort Tzerel........ 310
Svartklubben........ 309
Svendborg........ 312
Svenor........ 308
Sviatoi Nos........ 356
Svinoen........ 308
Swallow Bay........ 299
—— Islands........ 347
Swan Islands........ 286
Swansea........ 304
Swatow........ 337
Sweers Island........ 353
Swinemunde........ 310
Sybillo Bay........ 341
Sydenham Island........ 342
Sydney, Australia........ 352
—— Harbor, C. Breton I... 281
Synesvarde Mountain........ 308
Syra........ 319
Syracuse........ 317

Tabaco........ 335
Tabasco River........ 285
Tabertness........ 305
Tablas Island........ 335
—— Point........ 300
Table Bay........ 323
—— Head........ 279
—— Island........ 329
Taboga Island........ 291
Tabou River........ 322
Tacloban........ 335
Tacoma........ 289
Tacorady Bay........ 322
Tae Islands........ 337
Tagulanda Island........ 333
Tahiti........ 349
Tahoa Island........ 349
Tahuata Island........ 345
Taiaro Island........ 349
Tai-pin-san........ 338
Tajer, Port........ 318
Taka Yama........ 341
Takapoto Island........ 349
Takau........ 338
Takhkona Point........ 310
Talabo, Cape........ 333
Talcahuano........ 300
Talinay Mountain........ 300
Taltal, Port........ 301
Taluat Island........ 333
Tamana Island........ 342
Tamandaré........ 296
Tamar Port........ 299
Tamatave........ 326
Tambelan Island........ 331
Tampa Bay........ 284
Tampat Toewon Point........ 330
Tampico........ 285
Tamsui Harbor........ 338
Tanabe Bay........ 340
Tancook Island........ 281
Tanga Bay........ 324
Tangier........ 321
Tanjong Barram........ 333
—— Datu........ 333
—— Mangkalihat........ 333
—— Pandan........ 331
—— Patani........ 336
Tanna Island........ 347

PLACES—continued.

	Page.
Tantang, Port	326
Taoiunu	348
Taormina Cape	317
Tapua Island	347
Tapul Island	336
Taputeuea	342
Tara Hill	307
Taranto	317
Tarawa Island	342
Tarbertness	305
Tarifa	315
Taritari Island	342
Tarpaulin Cove	282
Tarragona	315
Tas de Foin Islet	339
Tatakoto	349
Tatsupi Saki	340
Tauere Island	349
Tauranga Harbor	354
Tauzon, Cape	326
Tavolara Cape	316
Tavoy River	329
Taytao Cape	300
Taytay Fort	333
Tchesmé	320
Tchoukotskoi, Cape	342
Tegal	331
Tehor Island	332
Tellicherri	328
Tello Islands	332
Tematangi Island	349
Tenasserim	329
Tenedos Island	320
Teneriffe Island	303
Tenez, Cape	321
Tepoca Cape	290
Tepoto Island	349
Tequepa	291
Terceira Island	302
Teresa, Sta., Bay	290
Terkolei	330
Terminos Lagoon	285
Ternate Island	333
Terstenik Rock	318
Testa, Cape	316
Testigos Islets	295
Tewaewae Bay	355
Thabi, Abu	327
Thank God Harbor	356
Thermia Island	319
Thikombia Island	348
Thithia Island	348
Thomas, St., I., B. of Biafra	322
—— —— ——West Indies	294
Thomé, St., Cape	297
Thorton Haven	338
Three Kings Islands	354
—— Points Cape, Africa	322
—— —— —— Argentina	298
—— —— —— Honduras	286
Ti-ao-usu Island	338
Tiburon Island	290
Tiegenort	310
Tien-pak	337
Tientsin	338
Tilly Bay	299
Timbalier Island	284
Timor Island	332
—— Laut Island	332
Tinakula Island	347
Tinian Island	344
Tintolo Point	335
Tirby Point	287
Tiruchendore	328
Toass Island	343
Toau	349
Tobago	295
Tobi Shima	340
Tobol Ali	331
Tocopilla	301
Todos Santos	290
To-du Island	325
Tofua Island	350
Tokara Jima	339
Tokelau Islands	345
Token Bessi Island	332
Tokio	340
Tolaga Bay	354
Tolkemit	310
Tomas, San	290
Tomo Roads	340
Tongarewa Island	345
Tongatabu Island	350
Tongka Harbor	329
Tongoi	300
Tong-sang Harbor	337
Tong-ting Islet	338
Tonning	311
Topolobampo	291
Tôr	324
Torbjornskjaer	308
Tordenskjold, Cape	356
Torgauten	308
Toriwi Saki	340
Tornea	309
Toro Point	287
Torres Island	347
—— Point	297
—— Port	316
Tortola	294
Tortosa, Cape	315
Tortugas Island	295
Tory Hill	307
—— Island	306
Tosco Cape	290
Totoya Island	348
Toulinguet Islands	279
Toulon	316
Tourane Bay	336
Towers Island	342
Townsend, Port	289
Trænen	307
Trafalgar, Cape	315
Tralee Bay	306
Trani	318
Trapani	317
Travemunde	311
Travers Islands	353
Treasury Islands	346
Trebizond	320
Tregosse Islands	347
Trelleborg	309
Tremiti Islands	317
Trepassey Harbor	279
Tres Montes Cape	299
—— Puntas Cape, Chile	299
—— —— —— Venezuela	296
Trevose Head	304
Triangles	285
Tribulation, Cape	353
Trieste	317
Trincomali	329
Tringano River	336
Trinidad Head	289
—— Island	303
Tripoli, Africa	321
—— Turkey	320
Tristan da Cunha	303
Triton Bay	346
—— Island	337
Triunfo Cape	286
Trivandrum	328
Trobriand Islands	347
Tromelin Island, Caroline Is.	343
—— —— Indian Ocean	326
Tromsö	307
Trondheim	307
Troon	305
Truxillo	286
Tsau-liang-hai	339
Tscheljuskin, Cape	356
Tsmano	326
Tsu Sima	339
Tsukarase Rocks	340
Tsuruga	340
Tuanske Island	349
Tubai Island	349
Tubuai Islands	350
Tubuai-Manu Island	349
Tucacas Island	295
Tuckers Beach	283
Tukume Island	349
Tully Mountain	306
Tumaco	302
Tumbez	302
Tung-chuh Island	338
Tung-yung Islands	337
Tuni-ang Island	337
Tunis	321
Tunö Island	312
Tupilco River	285
Tureia Island	349
Turk Island	292
Turnabout Island	337
Turö Island	312
Turtle Island	348
—— Isles	351
Tuskar Rock	307
Tuticorin	328
Tutoya	296
Tutuila Island	348
Tuvutha Island	348
Tuxpam Reefs	285
Tuxtla Volcano	285
Twelve Islands	327
Twofold Bay	352
Tybee Island	283
Ty-fung-kyoh Island	337
Tynemouth	305
Ua-Huka Island	345
Ualan Island	343
Ubatuba	297
Uea Island	348
Ujelang Island	343
Uji Shima	340
Uleaborg	309
Ulietea Island	349
Ulko Kalla Rock	309
Ulladulla	352
Ulsire	308
Uluthi Islands	343
Umea	309

PLACES—continued.

Page.

Una 297
Unalaska Island 287
Unare Bay 296
Underut Islet 325
Underwood, Port 355
Unga Island 287
Unie Island 318
Union Bay 298
—— Islands 345
—— Port de la 291
Unsang 333
Upernivik 356
Upright Port 299
Upsala 309
Upulo Islands 348
Uragami 340
Urracas Islands 344
Urup Island 341
Usborne, Port 351
Usedom 311
Ushant 313
Ustica Island 317
Ute Islet 309
Utilla Island 286
Utrecht 313
Uvea Island 350

Vadso 307
Vahanga Island 349
Vahitahi Island 349
Vaitupu Island 345
Valdes Island 288
Valdivia 300
Valencia 315
Valentia 306
Valentine Harbor 299
—— St., Cape 299
Valery en Caux, St 313
Valiente Peak 287
Valientes Islands 343
Valparaiso 300
Vanavana Island 349
Vancouver 289
Vanikoro 347
Vannes 314
Vanua Lava Island 347
—— Levu Island 348
—— Mbalavu Island 348
Vardo 307
Varella Cape 336
—— Pulo 336
Varna Bay 320
Vaté Island 347
Vathi, Port 319
Vatiu Island 350
Vatoa Island 348
Vatu Lele Island 347
—— Vara Island 348
Vavau Island 350
Vavitoa Island 350
Vaza Barris River 296
Veglia 317
Veirö Island 312
Vela, La, Cape 295
Venangue Bé Bay 326
Vendres, Port 316
Venice 317
Ver, Point de 313
Vera Cruz 285
Verde Cape 321

Page.

Verd Cay, Bahamas 292
—— —— Cuba 292
Vicente, San, Cape 299
—— —— Port 334
Victor, Port 352
Victoria 288
—— Harbor 355
—— Port, Australia 352
—— —— Seychelle Islands 325
—— River 351
Victory Cape 299
—— Island 331
Vidal, Cape 323
Video Island 338
Vieborg Bay 310
Vieques Island 294
Vieste 317
Vigan 334
Vigo 314
Villa 307
—— Nova da Princessa 297
Villajoyosa 315
Villefranche 316
Vinaroz 315
Vincent, San, de la Barquera 314
—— St. Cape, Chili 299
—— —— —— Madagascar 326
—— —— —— Portugal 315
—— —— I., C. Verde Is 303
—— —— —— Windward Is. 295
—— —— Bay, S. Pacific 350
Vineyard Haven 282
Vingorla 328
—— Rocks 328
Virgin Gorda 294
Virgins, Cape 298
Viti Levu 348
Vizagapatam 329
Viziadrug 328
Vladimir, St., Bay 341
Vladivostok 341
Vliko, Port 319
Vohemar 326
Vojazza River 318
Volcano Island, West 338
—— Islands 345
Volta River 322
Voltaire, Cape 351
Vordate Island 332
Vordingborg 312
Vostok Island 345
Vourlah 320
Vries Island 340

Waderö Island 308
Wadsworth, Fort 283
Wahdu Island 325
Waimea 344
Waitangi River 355
Wakaya Island 348
Wake Island 344
Wakefield, Port 352
Walfisch Bay 322
Walker Cay 292
Wallis Island 348
Walpole Island 347
Walsche, Cape 346
Walsingham, Cape 355
Wanganui River 354
Wangari Harbor 354

Page.

Wangaroa Harbor 354
Wangaruru 354
Wangeroog 312
Wang-kia-tia Bay 338
Warberg 308
Warnemunde 311
Warren Hastings Island 344
Washington 283
—— Island 342
Watch Hill Point 282
Watcher, North, Island 331
Waterfall Bluff 323
Waterford 307
Waterloo Bay 323
Watlings Island 292
Wawoda Rock 341
Wedge Island 281
Weggs Cape 279
Weichselmunde 310
Weihaiwei 338
Wellington 354
Wenman Island 342
Wessel, Cape 351
West Cape 355
Western, Port 352
Westminster Hall Islet 299
Wetta Island 332
Wexford 307
Whaingaroa Harbor 355
Whale Back 282
Whalefish Island 356
Whare-Kauri 350
White Haven 305
—— Head Island 281
—— Island 354
—— Rock
Whitsunday Island 349
Whittle Cape 280
Wicklow 307
Wilberforce, Cape 351
Wilhelmshaven 312
Willemstadt 313
William, Port 355
Willoughby, Cape 352
Wilmington 283
Wilson Islands 347
—— Islets 343
—— Promontory 352
Windau 310
Winter Harbor 355
Wismar 311
Wittgenstein Island 349
Wolgast 311
Wolkonsky Island 349
Wollaston Island 298
Wollin 310
Wollongong 352
Wood Island, Labrador 280
—— —— Maine 282
Woodlark Islands 347
Woody Island 337
Woosung 338
Wostenholme Cape 279
Wotje Islands 343
Wottho Island 343
Wowoni Island 333
Wrangell 288
Wrath, Cape 305
Wreck Reef 347
Wusimado Point 340
Wustrow 311

INDEX TO APPENDIX IV.

PLACES—continued.

Page.
Yakuno Shima 339
Yakutat Bay 288
Yamada 340
Yamagawa 340
Yami Island 334
Yañez 300
Yap Island 343
Yaquina Head 289
Yarmouth 281
Yeboshi Sima 339
Yembó 324
Yerabu-sima 339
Yeu, Island de 314
Ylin Island 334

Page.
Yobuko 339
Yoko Shima 339
Yokohama 340
Yokosuka 340
Yori-sima 339
York, Cape, Greenland 356
—— —— Queensland 353
—— Minister Rock 298
Youghal 307
Ystad 309
Ytapere Bay 326
—— Point 326
Yuiada Road 320
Yura No Uchi 340

Page.
Zafarana 324
Zafarin Islands 321
Zambesi River 323
Zamboanga 335
Zante 319
Zanzibar 324
Zapotitlan Point 285
Zara 318
—— Vecchia 318
Zempoala Point 285
Zengg 318
Zeyla 324
Zirona Grande Island 318

INDEX TO PART I.

Subject.	Art.	Page.
Abbreviations		7
Account. (*See* Dead reckoning.)		
Adjustments, horizon mirror	246	93
index mirror	245	93
plane table	413	192
sextant	244	93
permanent	248	94
theodolite or transit	410	190
Afternoon sights	389	171
Agulhas Current	544	237
Airy's method for great circle sailing	194	82
Alidade, plane table	412	192
Almanac, Nautical. (*See* Nautical Almanac.)		
Altitude and azimuth	235	90
time azimuth	356	147
azimuth	353	147
calculated, method of	371	155
circle, definition	217	88
circum-meridian	326	129
forms for		257
computed, method of	371	155
definition	220	88
ex-meridian	326	129
forms for		257
meridian, constant	325	128
form for		257
forms for		256
latitude by	321	126
observation of	322	126
reduction to	326	129
forms		257
observed, how corrected	294	115
of Polaris for latitude	333	136
single, for chronometer error	316	123
latitude	332	134
longitude ashore	340	141
at sea	341	142
true, definition	294	115
Altitudes, double, for chro. error	320	125
Amplitude, definition	224	89
determination of	347	144
Anchorage, position to be plotted	166	71
Angle, danger. (*See* Danger angle.)		
hour. (*See* Hour angle.)		
to repeat	411	191
Angles, between three known objects	152	62
horizon, for finding distance	139	58
round of	411	191
sextant and theodolite in hydrography	452	202
vertical terrestrial, to measure	139	58
26½°–45° on bow	147	60
Anticyclonic regions, features of	476	214
Apparent day, definition	273	102
variation in length	273	102
noon, definition	273	102
time, conversion to mean	292	110
definition	273	102
inequality of	273	102
Apparent time, relation to mean	288	109
Arctic Current	530	235
Aries, first point of, definition	226	89
Arming of lead	19	13
Artificial horizon, description	256	97
method of use	257	98
should be tested	258	98
Ascension, right. (*See* Right ascension.)		
Astronomical base	441	200
bearing	359	148
time	277	103
transit instruments	427	196
work of survey	445	201
Atlantic Ocean, currents	523	233
storms	489	224
Attraction, local	76	36
Australia Current	540	236
Axis of rotation, definition	6	9
Azimuth, altitude	353	147
and altitude	235	90
circle	34	18
definition	223	88
from Sumner line	370	153
how determined	345	144
named	344	144
of body determines use	395	174
terrestrial object	359	148
time and altitude	356	147
determination	349	145
diagram	351	145
for compass errors	89	40
in great circle sailing	191	82
tables	351	145
Barometer, aneroid	56	27
comparisons	57	27
definition	48	24
effect of, on tides	496	226
mercurial	49	24
sea	51	25
standard	51	25
temperature correction	55	26
to determine height	58	28
vernier	52	25
Base, astronomical	441	200
line, description	434	198
Beam compass, description	430	197
Bearing and angle, position by	143	59
distance, position by	138	57
danger	157	64
method of observing and plotting	134	56
of terrestrial object	359	148
Bearings, bow and beam	146	60
cross	134	56
sun, for compass error	89	40
two, of object, with run between	144	59
Beaufort's scale for wind	68	33
Bench mark, definition	511	230

Subject.	Art.	Page.
Binnacles, description	35	18
Bottom, quality of, on chart	46	23
Boxing the compass	27	14
Brazil Current	532	235
Buoys	162	66
C−W, definition	268	100
Calculated Altitude Method	371	155
Cape Horn Current	541	236
Celestial coordinates	234	90
equator, definition	215	88
horizon, definition	213	87
latitude and longitude	238	90
definition	229	89
meridian, definition	216	88
sphere or concave, definition	210	87
Celo-Navigation, definition	4	9
Chart. (*See also* Projection.)		
as record of piloting	166	71
employment in piloting	165	68
general features	37	20
great circle	189	80
for composite sailing	197	83
isobaric	460	270
measures of depth on	47	24
Mercator, to construct	41	21
quality of bottom on	46	23
standard meridians on	45	23
Chilean Current	541	236
Chronometer, advantage of more than one	265	100
C−W, definition	268	100
care on shipboard	260	98
comparison	263	99
record	264	99
correction. (*See* Chronometer error.)		
description	259	98
error, by double alts	320	125
single altitude	316	123
time sight	316	123
signals	314	121
transits	315	122
definition	261	98
differs from corr	312	121
from rate	311	121
hack, use of	268	100
max. and min. thermometer	262	99
minus watch, definition	268	100
second difference	265	100
sight. (*See* Time sight.)		
temperature curve	266	100
transportation of	260	98
winding	262	99
Circle, declination, definition	216	88
hour, definition	216	88
of altitude, definition	217	88
equal altitude	363	150
illumination	363	150
vertical definition	217	88
Circum-meridian altitude	326	129
forms	.....	257
Civil time	277	103
Clouds, description and symbols	71	34
Coefficients, constant	111	48
quadrantal	107	47
semicircular	103	46
value and relation	114	48
Collimation, line of, definition	410	190
Comparing watch, use of	268	100

Subject.	Art.	Page.
Comparison, barometer	57	27
chronometer, method	263	99
record	264	99
Compass, beam, description	430	197
boxing	27	14
compensation. (*See* Deviation.)		
declination	75	36
definition	25	14
deviation. (*See* Deviation.)		
divisions on card	26	14
dry	30	17
error. (*See* Error, compass.)		
local attraction	76	36
Lord Kelvin	32	17
Navy service, 7½-inch	31	17
variation	75	36
wet	30	17
Compasses (drawing)	7	11
Compensation, compass. (*See* Deviation.)		
Composite sailing, computation	198	83
definition	184	79
graphic approximation	199	83
shortest course for	196	83
terrestrial globe	200	83
Computed altitude method	371	155
Concave, celestial, definition	210	87
Constant deviation. (*See* Deviation.)		
for meridian altitude	325	128
form	.....	257
Conversion of time, apparent to mean	292	110
definition	286	108
mean to apparent	292	110
sidereal	290	110
sidereal to mean	291	110
Coordinates, celestial	234	90
definition	230	89
Correction, chro. (*See* Chronometer.)		
index, sextant	250	95
of observed altitude	294	115
Course, definition	6	10
to lay	132	56
Culmination, definition	271	102
Current, Agulhas	544	237
allowance for	206	86
Arctic	530	235
Australia	540	236
Brazil	532	235
Cape Horn	541	236
Chilean	541	236
determined at noon	388	171
effect in piloting	164	67
equatorial, Atlantic	523	233
Indian	543	237
Pacific	535	235
Guinea	529	235
Gulf Stream	526	233
Humboldt	541	236
Japan Stream	536	235
Kamchatka	537	236
Kuroshiwo	536	235
Labrador	530	235
ocean, Atlantic	523	233
cause of	517	232
definition	516	232
determination of	519	232
drift, definition	516	232
of Atlantic	523	233

Subject.	Art.	Page.
Current, ocean, Indian	542	237
Pacific	535	235
stream, definition	516	232
submarine	518	232
Oyashiwo	538	236
Peruvian	541	236
Rennells	531	235
Rossel	540	236
Southern connecting	533	235
tidal, definitions	490	225
description of	500	227
observation of	506	230
to find	207	86
Curve, temperature, chronometer	266	100
Cyclones and cyclonic circulations	475	213
Cyclonic regions, features of	476	214
storms, description	477	214
maneuvering in	486	221
summary of rules	487	222
tropical	478	214
character	481	218
Danger angle, horizontal	155	64
vertical	156	64
bearing	157	64
Data, useful, miscellaneous	.....	277
Day's work, routine	383	169
Dead reckoning, always kept	382	169
definition	202	84
form for	.....	254
method of working	205	84
value of	203	84
Decimal fractions	.....	266
Declination and hour angle	236	90
right ascension	237	90
circle, definition	216	88
definition	218	88
of compass	75	36
Declinatoire, plane table	412	192
Definitions, nautical astronomy	209	87
navigation	1	10
Departure, definition	6	10
on beginning voyage	382	169
to take	204	84
Depth, measures of, on charts	47	24
recorder, sounding machine	23	14
Deviation, causes of	99	44
classes of	100	45
compensation of	119	49
constant, coefficient	112	48
definition	111	48
definition	77	37
heeling error, compensation	125	53
definition	116	49
Napier diagram for	94	41
quadrantal, coefficients	107	47
definition	106	47
recompensation	128	54
semicircular, coefficients	103	46
definition	101	45
table	92	40
theory of	96	43
to apply	78	37
find	84	39
Diagram, time azimuth	351	145
Difference, second. (*See* Second difference.)		
Dip of horizon, definition	300	116
how applied	303	117
none with artificial horizon	294	115
variation in	301	117
when land intervenes	302	117

Subject.	Art.	Page.
Distance and bearing	138	57
by horizon angle	139	58
definition	6	9
of objects of known height	139	58
polar, definition	219	88
zenith. (*See* Zenith distance.)		
Distant object for compass error	91	40
Diurnal inequality of tide	498	227
type of tide	498	227
Dividers, description	7	11
proportional, description	431	197
Doldrums	465	209
Doubling angle on bow	145	60
Drift currents, Atlantic	527	234
Earth, definitions relating to	6	10
Eccentricity, sextant	248	94
Ecliptic, definition	225	89
Elevated pole	214	87
Ephemeris. (*See* Nautical Almanac.)		
Equation of time, definition	275	103
in conversion of time	288	109
Equator, celestial, definition	215	88
earth's	6	9
Equatorial currents. (*See* Current.)		
Equiangular spiral	6	10
Equinoctial, definition	215	88
Equinox, definition	226	89
vernal. (*See* First point of Aries.)		
Error, chro. (*See* Chronometer.)		
compass, causes	74	36
to apply	78	37
find	83	39
heeling. (*See* Deviation.)		
index, sextant, description	250	95
probable, of position, how shown	398	176
sextant. (*See* Sextant.)		
Establishment, tidal, definitions	492	226
Ex-meridian altitudes	326	129
forms	.....	257
Extraordinary refraction near horizon	301	117
Extra-tropical cyclonic storms	488	223
First point of Aries, definition	226	89
hour angle is sidereal time	276	103
Flinders bar, definition	105	47
to place	127	54
Fogs and fog signals	163	66
Forms for sights, etc	.....	254
notes on	.....	265
use recommended	399	176
Fractions, decimal	.....	266
Gauges, tide, description	513	231
Geodetic surveying	408	189
Geometry	.....	268
formulæ derived from	.....	269
Geo-Navigation, definition	4	9
Gimbals, compass	28	17
chronometer	259	98
Glasses, shade. (*See* Shade glasses.)		
Globe, terrestrial, for comp. sailing	200	83
gt. circle sailing	193	82
Graduation, sextant, error	248	94
Great circle charts	189	80
for comp. sailing	197	83
course	6	10
sailing, advantages	186	80
Airy's method	194	82
computation	190	81
definition	183	79
graphic approx	192	82

Subject.	Art.	Page.
Great circle sailing methods	188	80
terrestrial globe	193	82
time azimuth methods	191	82
Greenwich adopted as prime meridian	336	140
time, to find	280	104
Guinea Current	529	235
Gulf Stream, description	526	233
extraordinary dip in	301	117
Gyro-compass	33	18
Hack chronometer, use of	268	100
Heading, magnetic, determination of	122	50
Heeling error. (*See* Deviation.)		
Height, determination by barometer	58	28
Heliograph, use in surveying	426	195
Heliotrope, use in surveying	426	195
Horizon angle, distance by	139	58
artificial, description	256	97
method of use	257	98
no dip with	294	115
should be tested	258	98
celestial, definition	213	87
dip of, definition	300	116
how applied	303	117
none with artificial horizon	294	115
variation in	301	117
when land intervenes	302	117
mirror, adjustment	246	93
description	240	91
prismatic	248	95
visible or sea, definition	213	87
Horse latitudes	466	209
Hour angle and declination	236	90
time, conversion	293	111
definition	222	88
how measured	278	103
circle, definition	216	88
Humboldt Current	541	236
Hydrographic survey, method of	432	197
surveying, definition	408	189
Hydrography in survey, description	451	202
to plot	452	202
Ice and its movements in the North Atlantic Ocean	.....	238
Identification of unknown bodies	392	172
Index correction, sextant, to find	250	95
error, sextant, description	249	95
mirror, adjustment	245	93
description	240	91
prismatic	248	94
Indian Ocean, currents	542	237
Induction, magnetic	97	44
Instruments, astronomical transit	427	196
nautical astronomy	239	91
navigation	7	11
surveying	409	189
Interpolation, Nautical Almanac	283	106
Intersection, Sumner. (*See* Sumner.)		
Intervals, lunitidal, definitions	492	226
list of	.....	279
mean and sidereal time	289	109
Iron, hard and soft	97	44
Isobars, chart showing	460	270
Japan Stream	436	235
Kamchatka Current	537	236
Knot, length of	6	10
Kuroshiwo Current	536	235
Labrador Current	530	235
Lagging of tide	497	227
Land and sea breezes	469	211
Latitude, by meridian altitude	321	126
forms	.....	256
Polaris	333	136
reduction to meridian	326	129
reduction to meridian, forms	.....	257
single altitude	332	134
forms	.....	257
φ' φ'' method	332	134
forms	.....	257
celestial, definition	229	89
definition	6	9
difference, of definition	6	9
horse	466	209
Lead, arming	19	13
description	18	13
line, marking of	18	13
Level of bench mark	512	231
surveying, use of	425	195
description	424	195
Lights, employment in piloting	161	65
Line, base, description of	434	198
of collimation, definition	410	190
position. (*See* Sumner line.)		
sight, definition	410	190
Sumner. (*See* Sumner line.)		
Local attraction	76	36
time, to find	279	103
Log book	65	31
chip	10	11
ground	12	12
patent	13	12
electric registers	15	12
revolutions as substitute	17	13
Logarithms, explanation	.....	271
Longitude, by single altitude ashore	340	141
at sea	341	142
time sights, forms	.....	254
transit observations	338	140
celestial, definition	229	89
definition	6	9
difference of	6	9
of secondary meridians	339	141
tertiary meridians	339	141
Loxodromic Curve	6	10
Lubber's line	28	17
Lunitidal intervals, definitions	492	226
list of	.....	279
Magnetic observations in survey	456	204
Magnetism, acquired in building vessel	98	44
features of earth's	96	43
subpermanent	99	44
transient	99	44
Main triangulation	443	201
Maneuvering, cyclonic storms	486	221
summary of rules	487	222
Marine surveying	408	189
Mean day, definition	274	102
directive force	115	49
noon, definition	274	102
sun, definition	274	102
Mean time, conversion to apparent	292	110
sidereal	290	110
definition	274	102
intervals, relation to sidereal	289	109
time, relation to apparent	288	109
sidereal	287	108
Mercator projection, description	39	20
to construct	41	21
sailing	179	78

Subject.	Art.	Page.
Meridian altitude, constant	235	128
forms for		256
latitude by	321	126
observation of	322	126
reduction to	326	129
celestial, definition	216	88
of earth, definition	6	9
passage, definition	271	102
prime, Greenwich adopted	336	140
secondary, definition	336	140
determination of	337	140
standard, on charts	45	23
tertiary, definition	336	140
determination of	339	141
Meridional parts	40	20
Method of Saint Hilaire or of the computed altitudes	371	155
Middle latitude sailing	175	75
correction	178	77
Mile, nautical or sea, length of	6	10
Mirror, horizon. (*See* Horizon mirror.)		
index. (*See* Index mirror.)		
sextant, resilvering	254	96
Monsoon winds	468	210
Moon, correction of observed altitude	294	115
form for latitude sights		259
meridian altitude		257
time sight		256
planets, and stars, use of	391	172
value of observations of	394	174
Morning sights	384	169
Nadir, definition	212	87
Napier diagram	94	41
Nautical Almanac, description	282	105
for 1915, extracts		248
gives horizontal parallax	305	118
interpolation	283	106
reduction of elements	283	106
second differences	285	108
Astronomy, definitions	209	87
instruments	239	91
mile, length of	6	10
Navigation, definitions	1	9
instruments and accessories	7	11
Neap tides	494	226
Noon sights	386	170
Notes on forms for sights, etc		265
Occupying a station	411	190
Ocean current. (*See* Current, ocean.)		
Octant, description	255	97
Optical principal of sextant	242	92
Orient, to, a plane table	414	192
Oyashiwo current	538	236
Parallax, definition	304	118
horizontal, in Nautical Almanac	305	118
how applied	306	119
of planet or star	294	115
Parallel of latitude, definition	6	9
rulers, description	8	11
sailing, description	173	75
Passage, meridian, definition	271	102
Pelorus, description	36	19
Peruvian Current	541	236
Piloting, definition	130	56
requisites	131	56
Plane of reference, tidal	509	230
sailing	169	72
table, adjustments	413	192
description	412	191

Subject.	Art.	Page.
Plane table, to improvise	416	193
use of	413	193
Planet, correction of observed altitude	294	115
form for latitude sights		258
meridian altitude		256
time sight		255
identification of unknown	392	172
Planets, stars, and moon, use of	391	172
Polar distance, definition	219	88
Polaris, latitude by	333	136
Pole, elevated	214	87
star, latitude by	333	136
Poles of earth	6	9
Portable transit	427	196
Position by angles between 3 objects	152	62
26½°-45° on bow	147	60
bearing and angle	143	59
distance	138	57
bow and beam bearings	146	60
cross bearings	134	56
doubling angle on bow	145	60
two bearings and run	144	59
methods of fixing	133	56
of anchorage to be plotted	166	71
body determines its use	395	174
soundings in survey	452	202
probable error of by Sumner lines, how shown	398	176
Pressure, effect in wind	460	207
progressive areas of	474	212
seasonal variations in	461	207
variation of atmospheric	471	212
Prime meridian, Greenwich adopted	336	140
vertical, definition	217	88
Priming of tide	497	227
Projection, gnomonic	44	23
Mercator	39	20
polyconic	43	22
systems in use	38	20
Proportional dividers, description	431	197
Prosection method, plane table	414	192
Protractor, ordinary	9	11
three armed, description	428	196
substitute	429	196
use of	152	62
Quadrantal deviation. (*See* Deviation.)		
Quintant, description	255	97
Range of tide at various places		279
definitions	493	226
Ranges for finding compass error	90	40
in piloting	158	65
Rate, chronometer. (*See* Chronometer rate.)		
Reciprocal bearings for compass error	88	39
Reckoning, dead. (*See* Dead reckoning.)		
Record of astronomical work	399	176
chronometer comparisons	263	99
piloting	166	70
tidal	507	230
Red Sea, extraordinary dip in	301	117
Reduction to meridian	326	129
forms for		257
Reference, planes of, tidal	509	230
Refraction, correction for	298	116
definition	296	115
effect on dip	301	117
extraordinary, near horizon	301	117
how applied	299	116
Relative humidity	63	30
Rennells Current	531	235
Repeat, to, an angle	411	191

Subject.	Art.	Page.
Resection method, plane table	414	192
Residual deviation	123	52
Rhumb line, definition	6	10
not shortest course	185	80
Right ascension and declination	237	90
definition	237	90
Roaring forties	467	210
Rossel Current	540	236
Round of angles	411	191
Run, calculation of	208	86
determined at noon	388	171
Running survey, description	457	204
Sailing, composite. (*See* Composite.)		
great circle. (*See* Great circle.)	186	80
Mercator	179	78
middle latitude	175	75
correction	178	77
parallel	173	75
plane	169	·72
spherical	168	72
traverse	172	74
Sailings, definition	167	72
kinds of	168	72
Saint Hilaire's method	371	155
Sargasso sea	528	235
Sea and land breezes	469	211
mile, length of	6	10
symbols for state of	73	35
water temperature	64	30
Second difference, chronometer	265	100
Nautical Almanac	285	108
Secondary meridian, definition	336	140
determination of	337	140
triangulation	444	201
Seconds, employment in naut. sights	397	179
Semicircles, storm	485	221
Semicircular deviation. (*See* Deviation.)		
Semidiameter, definition	307	119
how applied	308	120
measured	251	96
of planet or star	294	115
Semidiurnal type of tide	498	227
Sextant adjustments	244	93
permanent	248	94
angles for plotting soundings	452	202
choice of	253	96
definition	239	91
description	240	91
eccentricity	248	94
graduation errors	248	94
index correction, to find	250	95
error, description	249	95
method of use	252	96
optical principle	242	92
prismatic mirrors	248	94
shade glasses	248	94
resilvering mirrors	254	96
surveying	423	195
vernier	241	92
Shade glasses, for artificial horizon	256	97
sextant, description	240	91
prismatic	248	94
Sidereal day, definition	276	103
noon, definition	276	103
time, conversion to mean	291	110
definition	276	103
intervals, relation to mean	289	109
relation to mean	287	108
Sight, chronometer. (*See* Time sight.)		
latitude. (*See* Latitude.)		

Subject.	Art.	Page.
Sight, line of, definition	410	190
longitude. (*See* Longitude.)		
time. (*See* Time sight.)		
Sights, afternoon	389	171
employment of various	396	175
morning	384	169
noon	386	170
Signals, surveying, description	442	200
time, for chronometer error	314	121
Silvering sextant mirrors	254	96
Solar time. (*See* Apparent time.)		
Solstice, definition	227	89
Sound, velocity of	314	122
Sounding machine, barometric corr	24	14
depth recorder	23	14
description	20	13
tubes	21	13
Soundings, surveying, how plotted	452	202
use in piloting	159	65
Southern connecting current	533	235
Sphere, celestial, definition	210	87
Spherical sailing	168	72
Spring tides	494	226
Stadia. (*See* Telemeter.)		
Star, correction of observed altitude	294	115
form for latitude sights	.....	258
meridian altitude	.....	256
time sight	.....	255
identification	393	173
observations in surveying	449	202
Stars, planets, and moon, use of	391	172
Station pointer. (*See* Protractor, three armed.)		
Storm center, motion of	479	215
rate of progress	479	215
to avoid	484	220
fix bearing	482	219
distance	483	219
semicircles	485	221
tables	487	223
Storms, along transatlantic routes	489	224
cyclonic. (*See* Cyclonic storms.)		
Submarine ocean currents	518	232
Sumner line, always recommended	384	170
applications of	390	171
choice of bodies	390	172
description	362	150
determination	369	152
uses	367	152
lines, intersection, computation	376	162
graphically	376	162
when run intervenes	380	166
Sun, correction of observed altitude	294	115
form for latitude sights	.....	256
meridian altitude	.....	256
time sight	.....	254
mean, definition	274	102
observations in surveying	449	202
Survey, astronomical work of	445	201
hydrographic, method of	432	197
running, description	457	204
to plot soundings in	452	202
Surveying, hydrographic, definition	408	189
instruments	409	189
marine, definition	408	189
topographic, definition	408	189
transit, description	409	189
Symbols for clouds	71	34
sea	73	35
weather	70	34
Table, plane. (*See* Plane table.)		

Subject.	Art.	Page.
Table, tide	501	228
time azimuth	351	145
Telemeter, description	417	194
substitute for	422	195
use of	417	194
Telescope, direct and reversed	411	191
sextant, adjustment	247	94
description	240	91
zenith	427	196
Temperature curve, chronometer	266	100
Terrestrial object, true bearing of	359	148
Tertiary meridian, definition	336	140
determination of	339	141
Theodolite, adjustments	410	190
angles for plotting soundings	451	203
description	409	189
method of use	411	190
Thermometer, classes of	59	28
description	59	28
dry and wet bulb	61	28
max. and min., chro	262	99
Three-armed protractor. (*See* Protractor.)		
point problem, conditions	153	63
explanation	152	62
Tidal current. (*See* Current, tidal.)		
day, definition	497	227
establishment, definitions	492	226
observations in survey	503	229
instructions for	503	229
record	507	230
Tide, bench mark, definition	511	230
cause of	491	225
definitions relating to	490	225
diurnal inequality	498	227
type	498	227
effect of, in piloting	164	67
wind and barometer on	496	226
gauges, description	513	231
observation of	504	229
planes of reference of	509	230
priming and lagging of	497	227
range of, at various places	.....	279
definitions	493	226
semidiurnal type	498	227
spring and neap	494	226
tables	501	228
time of high and low	501	228
form for	.....	259
tropic	498	227
types of	498	227
Time and altitude azimuth	356	147
hour angle, conversion of	293	111
apparent. (*See* Apparent time.)		
astronomical	277	103
at different meridians	279	103
azimuth. (*See* Azimuth, time.)		
civil	277	103
conversion of. (*See* Conversion.)		
equation of. (*See* Equation of time.)		
Greenwich, to find	280	104
local, to find	279	103
mean. (*See* Mean time.)		
of high and low water	501	228
form for	.....	259
Time of transit, how found	323	127
sidereal. (*See* Sidereal time.)		
signals for chronometer error	314	121
sight for chronometer error	316	123
longitude ashore	340	141
at sea	341	142
forms for	.....	254
solar. (*See* Apparent time.)		
Topographic surveying, definition	408	189
Topography in hydrographic survey	450	202
Tracing paper to plot soundings	160	65
3-point problem	429	196
Trade wind	464	209
Transit, astronomical	427	196
definition	271	102
observations for chronometer error	315	122
longitude	338	140
portable	427	196
surveying. (*See* Theodolite.)		
time of, how found	323	127
Traverse sailing	172	74
tables, use of	170	73
Triangulation, main	443	201
secondary	444	201
Trigonometric functions	.....	270
logarithms	.....	271
Tropic tide	498	227
Tropical cyclonic storms	478	214
character	481	218
Tubes, sounding machine	21	13
Unknown bodies, identification of	392	172
Useful data, miscellaneous	.....	277
Variation of compass, definition	75	36
to apply	78	37
find	83	39
Variations, atmospheric	471	212
nonperiodic	473	212
periodic	472	212
Vernier, barometer	52	25
sextant	241	92
theodolite	409	189
Vertical angles, terrestial, to measure	139	58
circle, definition	217	88
prime	217	88
Visible horizon, definition	213	87
Watch, comparing, use of	268	100
Weather symbols	70	34
Wind, Beaufort's scale	68	33
causes of	459	206
definition	458	206
doldrums	465	209
effect of, on tides	496	226
land and sea breezes	469	211
monsoon	468	210
normal pressure	460	207
prevailing	462	207
westerly	467	210
"Roaring forties"	467	210
storms. (*See* Cyclonic storms.)		
Trade	464	209
true direction and force	69	33
wire drag	454	208
Zenith, definition	212	87
distance, definition	221	88
how named	321	126
telescope	427	196

PART II.

TABLES.

PREFACE.

The following tables comprise Part II of the AMERICAN PRACTICAL NAVIGATOR, by the late Nathaniel Bowditch, LL. D., as revised in 1880 and in 1903, and again in 1914, under the direction of the Bureau of Navigation, Navy Department.

In the present edition, former tables 28A, 28B, 28C and 28D, Latitude by Polaris; 37, Logarithms for Equal Altitude Sights; 37A, Equation of Equal Altitudes near Noon, have been omitted, but the former assignment of table numbers and page numbers has not been disturbed, the pages on which these tables were printed being simply dropped from the book and the tables and pages not renumbered consecutively.

This edition has been extended by incorporating Table 45, Logarithmic and Natural Haversines; Table 46, Consolidated Altitude Corrections; Table 47, Longitude Factor, and Table 48, Latitude Factor.

HYDROGRAPHIC OFFICE,
Washington, D. C., 1916.

Note on Reprint of 1916.—This reprint is the same as the 1914 edition, except that a new table has been added—Table 49, corrections to be applied in order to find the true altitude of the moon from the observed altitude above the horizon.

CONTENTS OF PART II.

Page.
Explanation of the Tables ... 507
Table 1. Traverse Table, Quarter Points ... 515
2. Traverse Table, Degrees ... 531
3. Meridional Parts ... 621
4. Length of Degrees of Latitude and Longitude ... 629
5A. Distance of an Object by Two Bearings, Quarter Points ... 631
5B. Distance of an Object by Two Bearings, Degrees ... 634
6. Distance of Visibility of Objects of different Heights ... 640
7. Conversion of Arc and Time ... 641
8. Conversion of Sidereal into Mean Solar Time ... 642
9. Conversion of Mean Solar into Sidereal Time ... 645
10. Local mean time of Sun's visible Rising and Setting ... 648
11. Reduction of Moon's Meridian Passage for Longitude ... 672
12. Reduction of Quantities from Nautical Almanac ... 673
13. Change of Sun's Right Ascension ... 683
14. Dip of Sea Horizon ... 685
15. Dip at Distances short of Horizon ... 685
16. Parallax of Sun ... 685
17. Parallax of Planet ... 686
18. Augmentation of Moon's Semidiameter ... 687
19. Augmentation of Moon's Horizontal Parallax ... 687
20A. Mean Refraction ... 688
20B. Mean Refraction and Parallax of Sun ... 689
21. Correction of Refraction for Barometer ... 690
22. Correction of Refraction for Thermometer ... 691
23. Mean Refraction and Mean Parallax of Moon ... 693
24. Mean Refraction and Parallax of Moon ... 693
25. Variation of Altitude due to change of Declination ... 702
26. Variation of Altitude in one minute from Meridian ... 704
27. Variation of Altitude in given time from Meridian ... 714
28A.
28B.
28C. Omitted.
28D.
29. Nautical and Statute Miles ... 725
30. Conversion of Metric and English Linear Measure ... 726
31. Fahrenheit, Centigrade, and Réaumur Temperatures ... 727
32. True Force and Direction of Wind ... 728
33. Distance by Vertical Angle ... 729
34. Distance by Horizon Angle ... 731
35. Speed Table for Measured Mile ... 732
36. Local Mean and Standard Meridian Times ... 733
37.
37A. Omitted.
38. Error in Longitude produced by Error in Latitude ... 739
39. Amplitudes ... 740
40. Correction for Amplitude observed in Apparent Horizon ... 745
41. Natural Sines and Cosines ... 746
42. Logarithms of Numbers ... 755
43. Logarithms of Trigonometric Functions, Quarter Points ... 771
44. Logarithms of Trigonometric Functions, Degrees ... 772
45. Logarithmic and Natural Haversines ... 817
46. Consolidated table of Altitude Corrections ... 922
47. The Longitude Factor ... 938
48. The Latitude Factor ... 941
49. Corrections to be applied to observed altitude of the moon ... 946

TABLE 6: DISTANCE OF VISIBILITY OF OBJECTS.

This table contains the distances, in nautical and statute miles, at which any object is visible at sea. It is calculated by the formulæ:

$$d = 1.15\sqrt{x}, \text{ and } d' = 1.32\sqrt{x},$$

in which d is the distance in nautical miles, d' the distance in statute miles, and x the height of the eye or the object in feet.

To find the distance of visibility of an object, the distance given by the table corresponding to its height should be added to that corresponding to the height of the observer's eye.

Example: Required the distance of visibility of an object 420 feet high, the observer being at an elevation of 15 feet.

Dist. corresponding to 420 feet,	23.5 naut. miles.
Dist. corresponding to 15 feet,	4.4 naut. miles.
Dist. of visibility,	27.9 naut. miles.

TABLE 7: CONVERSION OF ARC AND TIME.

In the first column of each pair in this table are contained angular measures expressed in arc (degrees, minutes, or seconds), and in the second column the corresponding angles expressed in time (hours, minutes, or seconds). As will be seen from the headings of columns, the time corresponding to degrees (°) is given in hours and minutes; to minutes of arc (′), in minutes and seconds of time; and to seconds of arc (″), in seconds and sixtieths of a second of time.

The table will be especially convenient in dealing with longitude and hour angle. The method of its employment is best illustrated by examples.

Example I.

Required the time corresponding to 50° 31′ 21″.

$$\begin{array}{rrrcrrr} 50^\circ & 00' & 00'' & = & 3^h & 20^m & 00^s \\ & 31 & 00 & = & & 2 & 04 \\ & & 21 & = & & & 1\frac{24}{60} \\ \hline 50 & 31 & 21 & = & 3 & 22 & 05.4 \end{array}$$

Example II.

Required the arc corresponding to $6^h\ 33^m\ 26^s.5$.

$$\begin{array}{rrrcrrr} 6^h & 32^m & 00^s & = & 98^\circ & 00' & 00'' \\ & 1 & 24 & = & & 21 & 00 \\ & & 2\frac{30}{60} & = & & & 37.5 \\ \hline 6 & 33 & 26.5 & = & 98 & 21 & 37.5 \end{array}$$

TABLES 8 AND 9: SIDEREAL AND MEAN SOLAR TIMES.

These tables give, respectively, the reductions necessary to convert intervals of sidereal time into those of mean solar time, and intervals of mean solar into those of sidereal time. The reduction for any interval is found by entering with the number of hours at the top and the number of minutes at the side, adding the reduction for seconds as given in the margin.

The relations between mean solar and sidereal time intervals, and the methods of conversion of these times, are given in articles 289–291, Chapter IX.

TABLE 10: SUN'S RISING AND SETTING.

This table gives the local mean time of the sun's visible rising and setting—that is, of the appearance and disappearance of the sun's upper limb in the unobstructed horizon of a person whose eye is 15 feet above the level of the earth's surface, the atmospheric conditions being normal.

The local apparent times of rising and setting were determined from the formula for a time sight, the altitude employed being −0° 56′ 08″, made up of the following terms: Refraction, −36′ 29″; semidiameter, −16′ 00″; dip, −3′ 48″; and parallax, +9″.

To ascertain the time of rising or setting for any given date and place, enter the table with the latitude and declination, interpolating if the degrees are not even. In the line R will be found the time of rising; in the line S, the time of setting. Be careful to choose the page in which the latitude is of the correct name, and in which the "approximate date" corresponds, nearly or exactly, with the given date.

This table is computed with the intention that, if accuracy is desired, it will be entered with the declination as an argument—not the date—as it is impossible to construct any table based upon dates whose application shall be general to all years. But as a given degree of declination will, in the majority of years, fall upon the date given in the table as the "approximate date," and as, when it does not do so, it can never be more than one day removed therefrom, it will answer, where a slight inaccuracy may be admitted, to enter the table with the date as an argument, thus avoiding the necessity of ascertaining the declination.

Example: Find the local mean time of sunset at Rio de Janeiro, Brazil (lat. 22° 54′ S., long. 43° 10′ W.), on January 1, 1903 (dec. 23° 04′ S.).

Exact method.

Lat. 22° Dec. 23°	$6^h\ 48^m$
Corr. for + 54′ lat	+ 02
Corr. for + 04′ dec.	00
L. M. T. sunset	6 50

Approximate method.

Lat. 22° January 2	$6^h\ 48^m$
Corr. for + 54′ lat.	+ 02
Corr. for 1 day	− 01
L. M. T. sunset	6 49

TABLE 11: REDUCTION FOR MOON'S TRANSIT.

This table was calculated by proportioning the daily variation of the time of the moon's passing the meridian.

The numbers taken from the table are to be added to the Greenwich time of moon's transit in west longitude, but subtracted in east longitude.

TABLE 12: REDUCTIONS FOR NAUTICAL ALMANAC.

This is a table of proportional parts for finding the variation of the sun's right ascension or declination, or of the equation of time, in any number of minutes of time, the horary motion being given at the top of the page in seconds, and the number of minutes of time in the side column; also for finding the variation of the moon's declination or right ascension in any number of seconds of time, the motion in one minute being given at the top, and the numbers in the side column being taken for seconds.

TABLE 13: CHANGE OF SUN'S RIGHT ASCENSION.

This is a table that may be employed for finding the change of the sun's right ascension for any given number of hours, the hourly change, as taken from the Nautical Almanac, being given in the marginal columns.

TABLE 14: DIP OF SEA HORIZON.

This table contains the dip of the sea horizon, calculated by the formula:

$$D = 58''.8 \sqrt{F},$$

in which F = height of the eye above the level of the sea in feet.

It is explained in article 300, Chapter X.

TABLE 15: DIP SHORT OF HORIZON.

This table contains the dip for various distances and heights, calculated by the formula:

$$D = \frac{3}{7} d + 0.56514 \times \frac{h}{d},$$

in which D represents the dip in miles or minutes, d, the distance of the land in sea miles, and h, the height of the eye of the observer in feet.

TABLE 16: PARALLAX OF SUN.

This table contains the sun's parallax in altitude calculated by the formula:

$$\text{par.} = \sin z \times 8''.75,$$

in which z = apparent zenith distance, the sun's horizontal parallax being 8''.75.

It is explained in article 304, Chapter X.

TABLE 17: PARALLAX OF PLANET.

Parallax in altitude of a planet is found by entering at the top with the planet's horizontal parallax, and at the side with the altitude.

TABLE 18: AUGMENTATION OF MOON'S SEMIDIAMETER.

This table gives the augmentation of the moon's semidiameter calculated by the formula:

$$x = c\, s^2 \sin h + \tfrac{1}{2} c^2 s^3 \sin^2 h + \tfrac{1}{2} c^2 s^3,$$

where h = moon's apparent altitude;
s = moon's horizontal semidiameter;
x = augmentation of semidiameter for altitude h; and
$\log c = 5.25021$.

TABLE 19: AUGMENTATION OF MOON'S HORIZONTAL PARALLAX.

This table contains the augmentation of the moon's horizontal parallax, or the correction to reduce the moon's equatorial horizontal parallax to that point of the earth's axis which lies in the vertical of the observer in any given latitude; it is computed by the formulæ:

$$\Delta \pi = \pi (b - 1), \qquad b = \frac{1}{\sqrt{(1 - e^2 \sin^2 L)}},$$

where π = equatorial horizontal parallax;
L = latitude;
e = eccentricity of the meridian; $\log e^2 = 7.81602$; and
$\Delta \pi$ = augmentation of the horizontal parallax for the latitude L.

TABLE 20A: MEAN REFRACTION.

This table gives the refraction, reduced from Bessel's tables, for a mean atmospheric condition in which the barometer is 30.00 inches, and thermometer 50° Fahr.

TABLE 20B: MEAN REFRACTION AND PARALLAX OF SUN.

This table contains the correction to be applied to the sun's apparent altitude for mean refraction and parallax, being a combination of the quantities for the altitudes given in Tables 16 and 20A.

TABLES 21, 22: CORRECTIONS OF REFRACTION FOR BAROMETER AND THERMOMETER.

These are deduced from Bessel's tables. The method of their employment will be evident.

TABLE 23: MEAN REFRACTION AND MEAN PARALLAX OF MOON.

This table contains the correction of the moon's altitude for refraction and parallax corresponding to the mean refraction (Table 20A), and a horizontal parallax of the mean value of 57′ 30″.

TABLE 24: MEAN REFRACTION AND PARALLAX OF MOON.

This table contains the correction to be applied to the moon's apparent altitude for each minute of horizontal parallax, and for every 10′ of altitude from 5°, with height of barometer 30.00 inches, and thermometer 50° Fahr.

For seconds of parallax, enter the table abreast the approximate correction and find the seconds of horizontal parallax, the tens of seconds at the side and the units at the top. Under the latter and opposite the former will be the seconds to add to the correction.

For minutes of altitude, take the seconds from the extreme right of the page, and apply them as there directed.

TABLE 25: CHANGE OF ALTITUDE DUE TO CHANGE OF DECLINATION.

This table gives the variation of the altitude of any heavenly body arising from a change of 100″ in the declination. It is useful for finding the equation of equal altitudes by the approximate method explained in article 324, Chapter XI, and for other purposes.

If the change move the body toward the elevated pole, apply the correction to the altitude with the signs in the table; otherwise change the signs.

TABLE 26: CHANGE OF ALTITUDE IN ONE MINUTE FROM MERIDIAN.

This table gives the variation of the altitude of any heavenly body, for one minute of time from meridian passage, for latitudes up to 60°, declinations to 63°, and altitudes between 6° and 86°. It is based upon the method set forth in article 328, Chapter XII, and the values may be computed by the formula:

1.9635

$$a=\frac{1''.9635 \cos L \cos d}{\sin (L-d)},$$

where a = variation of altitude in one minute from meridian,
L = latitude, and
d = declination—positive for same name and negative for opposite name to latitude at upper transit, and negative for same name at lower transit.

The limits of the table take in all values of latitude, declination, and altitude which are likely to be required. In its employment, care must be taken to enter the table at a place where the declination is appropriately named (of the same or opposite name to the latitude); it should also be noted that at the bottom of the last three pages values are given for the variation of a body at *lower* transit, which can only be observed when the declination and latitude are of the same name, and in which case the reduction to the meridian is subtractive; the limitations in this case are stated at the *foot* of the page, and apply to all values below the heavy rules.

TABLE 27: CHANGE OF ALTITUDE IN GIVEN TIME FROM MERIDIAN.

This table gives the product of the variation in altitude in one minute of a heavenly body near the meridian, by the square of the number of minutes. Values are given for every half minute between $0^m\ 30^s$ and $26^m\ 0^s$, and for all variations likely to be employed in the method of "reduction to the meridian."

The formula for computing is:

Red. $= a \times t^2$,
where a = variation in one minute (Table 26), and
t = number of minutes (in units and tenths) from time of meridian passage.

The table is entered in the column of the nearest interval of time from meridian, and the value taken out corrresponding to the value of a found from Table 26. The units and tenths are picked out separately and combined, each being corrected by interpolation for intermediate intervals of time.

The result is the amount to be applied to the observed altitude to reduce it to the meridian altitude, which is always to be added for upper transits and subtracted for lower.

TABLE 28, A, B, C, D: LATITUDE BY POLARIS.

[OMITTED.]

TABLES 29, 30, 31: CONVERSION TABLES.

These are self-explanatory.

TABLE 32: TRUE FORCE AND DIRECTION OF WIND.

This table enables an observer on board of a moving vessel to determine the true force and direction of the wind from its apparent force and direction. Enter the table with the apparent direction of the wind (number of points on the bow) and force (Beaufort scale) as arguments, and pick out the direction relatively to the ship's head and the force corresponding to the known speed of the ship.

EXAMPLE: A vessel steaming SE. at a speed of 15 knots appears to have a wind blowing from three points on the starboard bow with a force of 6, Beaufort scale. What is the true direction and force?

In the column headed 3 (meaning three points on bow, apparent direction) and in the line 6 (apparent force, Beaufort scale), we find abreast 15 (knots, speed of vessel) that the true direction is 5 points on starboard bow, *i. e.*, S. by W., and true force 4.

TABLE 33: VERTICAL ANGLES.

This table gives the distance of an object of known height by the vertical angle that it subtends at the position of the observer. It was computed by the formula:

$$\tan \alpha = \frac{h}{d},$$

where α = the vertical angle;
h = the height of the observed object in feet; and
d = the distance of the object, also converted into feet.

The employment of this method of finding distance is explained in article 139, chapter IV.

TABLE 34: HORIZON ANGLES.

This shows the distance in yards corresponding to any observed angle between an object and the sea horizon beyond, the observer being at a known height.

The method of use is explained in article 139, chapter IV.

TABLE 35: SPEED TABLE.

This table shows the rate of speed, in nautical miles per hour, of a vessel which traverses a measured mile in any given number of minutes and seconds. It is entered with the number of minutes at the top and the number of seconds at the side; under one and abreast the other is the number of knots of speed.

TABLE 36: LOCAL AND STANDARD TIMES.

This table contains the reduction to be applied to the local time to obtain the corresponding time at any other meridian whose time is adopted as a standard. The results are given to the nearest minute of time only; being intended for the reduction of such approximate quantities as the time of high water or time of sunset. More exact reductions, when required, may be made by Table 7.

TABLE 37: LOGARITHMS FOR EQUAL ALTITUDE SIGHTS.

[OMITTED.]

TABLE 37A: EQUATION OF EQUAL ALTITUDES NEAR NOON.

[OMITTED.]

TABLE 38: EFFECT UPON LONGITUDE OF ERROR IN LATITUDE.

Table 38 shows, approximately, the error in longitude in miles and tenths of a mile, occasioned by an error of one mile in the latitude.

Thus, when the sun's altitude is 30°, the latitude 30°, and the polar distance 100°, the error is eight-tenths of a mile.

The effect of an *increase* of latitude is as follows:

In *West* longitude, the body being $\left\{\begin{matrix}\text{East}\\ \text{West}\end{matrix}\right\}$ of meridian, the longitude is $\left\{\begin{matrix}\text{decreased}\\ \text{increased}\end{matrix}\right\}$, except where marked by *, when it is $\left\{\begin{matrix}\text{increased}\\ \text{decreased}\end{matrix}\right\}$.

In *East* longitude, the body being $\left\{\begin{matrix}\text{East}\\ \text{West}\end{matrix}\right\}$ of meridian, the longitude is $\left\{\begin{matrix}\text{increased}\\ \text{decreased}\end{matrix}\right\}$, except where marked by *, when it is $\left\{\begin{matrix}\text{decreased}\\ \text{increased}\end{matrix}\right\}$.

A *decrease* of latitude has the contrary effect.

The direction of error may readily be seen by drawing the Sumner line in a direction at right angles to the approximate bearing of the body.

TABLE 39: AMPLITUDES.

This table contains amplitudes of heavenly bodies, at rising and setting, for various latitudes and declinations, computed by the formula:

$$\sin \text{amp.} = \sec. \text{Lat.} \times \sin \text{dec.}$$

It is entered with the declination at the top and the latitude at the side.

Its use is explained in article 358, Chapter XIV.

TABLE 40: CORRECTION FOR AMPLITUDES.

This table gives a correction to be applied to the observed amplitude to counteract the vertical displacement due to refraction, parallax, and dip, when the body is observed with its center in the visible horizon.

The correction is to be applied for the sun, a planet, or a star, as follows:

$$\left.\begin{array}{r}\text{At Rising in N. Lat.}\\ \text{Setting in S. Lat.}\end{array}\right\}\text{apply the correction to the right.}$$

$$\left.\begin{array}{r}\text{At Rising in S. Lat.}\\ \text{Setting in N. Lat.}\end{array}\right\}\text{apply the correction to the left.}$$

For the moon, apply *half* the correction in the *contrary* manner.

TABLE 41: NATURAL SINES AND COSINES.

This table contains the natural sine and cosine for every minute of the quadrant, and is to be entered at the top or bottom with the degrees, and at the side marked M., with the minutes; the corresponding numbers will be the natural sine and cosine, respectively, observing that if the degrees are found at the top, the name sine, cosine, and M. must also be found at the top, and the contrary if the degrees are found at the bottom. It should be understood that all numbers given in the table should be divided by 100,000—that is, pointed off to contain five decimal places. Thus, .43366 is the natural sine of 25° 42′, or the cosine of 64° 18′.

In the outer columns of the margin are given tables of proportional parts, for the purpose of finding, approximately, by inspection, the proportional part corresponding to any number of seconds in the proposed angle, the seconds being found in the marginal column marked M., and the correction in the adjoining column. Thus, if we suppose that it were required to find the natural sine corresponding to 25° 42′ 19″, the difference of the sines of 25° 42′ and 25° 43′ is 26, being the same as at the top of the left-hand column of the table; and in this column, and opposite 19 in the column M., is the correction 8. *Adding* this to the above number .43366, because the numbers are *increasing*, we get .43374 for the sine of 25° 42′ 19″. In like manner, we find the cosine of the same angle to be .90108−4=.90104, using the right-hand columns, and *subtracting* because the numbers are *decreasing;* observing, however, that the number 14 at the top of this column varies 1 from the difference between the cosines of 25° 42′ and 25° 43′, which is only 13; so that the table may give in some cases a unit too much between the angles 25° 42′ and 25° 43′; but this is, in general, of but little importance, and when accuracy is required, the usual method of proportional parts is to be resorted to, using the actual tabular difference.

TABLE 42: LOGARITHMS OF NUMBERS.

This table, containing the common logarithms of numbers, was compared with Sherwin's, Hutton's, and Taylor's logarithms; its use is explained in an article on Logarithms in Appendix III.

TABLE 43: LOGARITHMS OF TRIGONOMETRIC FUNCTIONS, QUARTER POINTS.

This table contains the logarithms of the sines, tangents, etc., corresponding to points and quarter points of the compass. This was compared with Sherwin's, Hutton's, and Taylor's logarithms.

TABLE 44: LOGARITHMS OF TRIGONOMETRIC FUNCTIONS, DEGREES.

This table contains the common logarithms of the sines, tangents, secants, etc. It was compared with Sherwin's, Hutton's, and Taylor's tables. Two additional columns are given in this table, which are very convenient in finding the time from an altitude of the sun; also, three columns of proportional parts for seconds of space, and a small table at the bottom of each page for finding the proportional parts for seconds of time. The degrees are marked to 180°, which saves the trouble of subtracting the given angle from 180° when it exceeds 90°.

The use of this table is fully explained in Appendix III in an article on Logarithms.

TABLE 45: LOGARITHMIC AND NATURAL HAVERSINES.

The haversine is defined by the following relation:

$$\text{hav. }A=\tfrac{1}{2}\text{ vers. }A=\tfrac{1}{2}(1-\cos A)=\sin^2\tfrac{1}{2}A.$$

It is a trigonometric function which simplifies the solution of many problems in nautical astronomy as well as in plane trigonometry. To afford the maximum facility in carrying out the processes of solution, the values of the natural haversine and its logarithm are set down together in a single table for all values of angle ranging from 0° to 360°, expressed both in arc and in time.

TABLE 46: CORRECTIONS TO BE APPLIED IN ORDER TO FIND THE TRUE ALTITUDE OF A STAR AND ALSO OF THE SUN FROM THE OBSERVED ALTITUDE ABOVE THE HORIZON.

This is a consolidated table in which the tabulated correction for an observed altitude of a star combines the mean refraction and the dip, and that for an observed altitude of the sun's lower limb combines the mean refraction, the dip, the parallax, and the mean semidiameter, which is taken as 16′. A supplementary table at the foot of the main table takes account of the variation of the sun's semidiameter in the different months of the year.

TABLE 47: THE LONGITUDE FACTOR.

The change in longitude due to a change of 1′ in latitude, called the longitude factor, F, is given in this table at suitable intervals of latitude and azimuth. The quantities tabulated are computed from the formula—

$$F = \text{sec. Lat.} \times \text{cot. Az.}$$

When a time sight is solved with a dead-reckoning latitude, the resulting longitude is only true if the latitude be correct. This table, by setting forth the number of minutes of longitude due to each minute of error in latitude, gives the means of finding the correction to the longitude for any error that may subsequently be disclosed in the latitude used in the calculation.

Regarding the azimuth of the observed celestial body as less than 90° and as measured from either the North or the South point of the horizon towards East or West, the rule for determining whether the correction in longitude is to be applied to the eastward or to the westward will be as follows: If the change in latitude is of the same name as the first letter of the bearing, the change in longitude is of the contrary name to that of the second letter, and vice versa.

Thus, if the body bears S. 45° E. and the change in latitude is to the southward, the change in longitude will be to the westward; and, if the change in latitude is to the northward, the change in longitude will be to the eastward.

The convenient application of the longitude factor in finding the intersection of Sumner lines is explained in article 389.

TABLE 48: THE LATITUDE FACTOR.

The change in latitude due to a change of 1′ in the longitude, called the latitude factor, f, is given in this table at suitable intervals of latitude and azimuth. The quantities tabulated, being the reciprocals of the values of the longitude factor, are computed from the formula—

$$f = \frac{1}{F} = \frac{1}{\text{sec. Lat.} \times \text{cot. Az.}} = \text{cos. Lat.} \times \text{tan. Az.}$$

When an ex-meridian sight is solved with a longitude afterwards found to be in error, this table, by setting forth the number of minutes of latitude due to each 1′ of error in longitude, gives the means of finding the correction in the latitude for the amount of error in the longitude used in the calculation.

Regarding the azimuth of the observed celestial body as less than 90° and as measured from either the North or the South point of the horizon towards East or West, the rule for determining whether the correction in latitude is to be applied to the northward or to the southward is as follows: If the change in longitude is of the same name as the second letter of the bearing, the change in latitude is of the contrary name to the first letter, and vice versa. Thus, if the body bears S. 14° E. and the change in longitude is to the westward, the change in latitude will be to the southward, and, if the change in longitude is to the eastward, the change in latitude will be to the northward.

The convenient application of the latitude factor in finding the intersection of Sumner lines is explained in article 390.

TABLE 49: CORRECTIONS TO BE APPLIED IN ORDER TO FIND THE TRUE ALTITUDE OF THE MOON FROM THE OBSERVED ALTITUDE ABOVE THE HORIZON.

In this table, which is to be entered with the observed altitude in the side column and from the top with the horizontal parallax as obtained from the Nautical Almanac for the time of observation, there are set down the corrections to be applied to the observed altitude of the moon's upper limb above the horizon, and also of the lower limb, giving the combined effect of the dip of the horizon for a height of the eye of the observer of 35 feet above the level of the sea, of the astronomical refraction for the mean state of the atmosphere, and of the parallax and semidiameter of the moon.

A supplementary table, following the main table, takes account of heights of the eye of the observer differing from 35 feet.

TABLE 1.

Difference of Latitude and Departure for ¼ Point.

N. ¼ E. N. ¼ W. S. ¼ E. S. ¼ W.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	1.0	0.0	61	60.9	3.0	121	120.9	5.9	181	180.8	8.9	241	240.7	11.8
2	2.0	0.1	62	61.9	3.0	22	121.9	6.0	82	181.8	8.9	42	241.7	11.9
3	3.0	0.1	63	62.9	3.1	23	122.9	6.0	83	182.8	9.0	43	242.7	11.9
4	4.0	0.2	64	63.9	3.1	24	123.9	6.1	84	183.8	9.0	44	243.7	12.0
5	5.0	0.2	65	64.9	3.2	25	124.8	6.1	85	184.8	9.1	45	244.7	12.0
6	6.0	0.3	66	65.9	3.2	26	125.8	6.2	86	185.8	9.1	46	245.7	12.1
7	7.0	0.3	67	66.9	3.3	27	126.8	6.2	87	186.8	9.2	47	246.7	12.1
8	8.0	0.4	68	67.9	3.3	28	127.8	6.3	88	187.8	9.2	48	247.7	12.2
9	9.0	0.4	69	68.9	3.4	29	128.8	6.3	89	188.8	9.3	49	248.7	12.2
10	10.0	0.5	70	69.9	3.4	30	129.8	6.4	90	189.8	9.3	50	249.7	12.3
11	11.0	0.5	71	70.9	3.5	131	130.8	6.4	191	190.8	9.4	251	250.7	12.3
12	12.0	0.6	72	71.9	3.5	32	131.8	6.5	92	191.8	9.4	52	251.7	12.4
13	13.0	0.6	73	72.9	3.6	33	132.8	6.5	93	192.8	9.5	53	252.7	12.4
14	14.0	0.7	74	73.9	3.6	34	133.8	6.6	94	193.8	9.5	54	253.7	12.5
15	15.0	0.7	75	74.9	3.7	35	134.8	6.6	95	194.8	9.6	55	254.7	12.5
16	16.0	0.8	76	75.9	3.7	36	135.8	6.7	96	195.8	9.6	56	255.7	12.6
17	17.0	0.8	77	76.9	3.8	37	136.8	6.7	97	196.8	9.7	57	256.7	12.6
18	18.0	0.9	78	77.9	3.8	38	137.8	6.8	98	197.8	9.7	58	257.7	12.7
19	19.0	0.9	79	78.9	3.9	39	138.8	6.8	99	198.8	9.8	59	258.7	12.7
20	20.0	1.0	80	79.9	3.9	40	139.8	6.9	200	199.8	9.8	60	259.7	12.8
21	21.0	1.0	81	80.9	4.0	141	140.8	6.9	201	200.8	9.9	261	260.7	12.8
22	22.0	1.1	82	81.9	4.0	42	141.8	7.0	02	201.8	9.9	62	261.7	12.9
23	23.0	1.1	83	82.9	4.1	43	142.8	7.0	03	202.8	10.0	63	262.7	12.9
24	24.0	1.2	84	83.9	4.1	44	143.8	7.1	04	203.8	10.0	64	263.7	13.0
25	25.0	1.2	85	84.9	4.2	45	144.8	7.1	05	204.8	10.1	65	264.7	13.0
26	26.0	1.3	86	85.9	4.2	46	145.8	7.2	06	205.8	10.1	66	265.7	13.1
27	27.0	1.3	87	86.9	4.3	47	146.8	7.2	07	206.8	10.2	67	266.7	13.1
28	28.0	1.4	88	87.9	4.3	48	147.8	7.3	08	207.7	10.2	68	267.7	13.2
29	29.0	1.4	89	88.9	4.4	49	148.8	7.3	09	208.7	10.3	69	268.7	13.2
30	30.0	1.5	90	89.9	4.4	50	149.8	7.4	10	209.7	10.3	70	269.7	13.2
31	31.0	1.5	91	90.9	4.5	151	150.8	7.4	211	210.7	10.4	271	270.7	13.3
32	32.0	1.6	92	91.9	4.5	52	151.8	7.5	12	211.7	10.4	72	271.7	13.3
33	33.0	1.6	93	92.9	4.6	53	152.8	7.5	13	212.7	10.5	73	272.7	13.4
34	34.0	1.7	94	93.9	4.6	54	153.8	7.6	14	213.7	10.5	74	273.7	13.4
35	35.0	1.7	95	94.9	4.7	55	154.8	7.6	15	214.7	10.5	75	274.7	13.5
36	36.0	1.8	96	95.9	4.7	56	155.8	7.7	16	215.7	10.6	76	275.7	13.5
37	37.0	1.8	97	96.9	4.8	57	156.8	7.7	17	216.7	10.6	77	276.7	13.6
38	38.0	1.9	98	97.9	4.8	58	157.8	7.8	18	217.7	10.7	78	277.7	13.6
39	39.0	1.9	99	98.9	4.9	59	158.8	7.8	19	218.7	10.7	79	278.7	13.7
40	40.0	2.0	100	99.9	4.9	60	159.8	7.9	20	219.7	10.8	80	279.7	13.7
41	41.0	2.0	101	100.9	5.0	161	160.8	7.9	221	220.7	10.8	281	280.7	13.8
42	41.9	2.1	02	101.9	5.0	62	161.8	7.9	22	221.7	10.9	82	281.7	13.8
43	42.9	2.1	03	102.9	5.1	63	162.8	8.0	23	222.7	10.9	83	282.7	13.9
44	43.9	2.2	04	103.9	5.1	64	163.8	8.0	24	223.7	11.0	84	283.7	13.9
45	44.9	2.2	05	104.9	5.2	65	164.8	8.1	25	224.7	11.0	85	284.7	14.0
46	45.9	2.3	06	105.9	5.2	66	165.8	8.1	26	225.7	11.1	86	285.7	14.0
47	46.9	2.3	07	106.9	5.3	67	166.8	8.2	27	226.7	11.1	87	286.7	14.1
48	47.9	2.4	08	107.9	5.3	68	167.8	8.2	28	227.7	11.2	88	287.7	14.1
49	48.9	2.4	09	108.9	5.3	69	168.8	8.3	29	228.7	11.2	89	288.7	14.2
50	49.9	2.5	10	109.9	5.4	70	169.8	8.3	30	229.7	11.3	90	289.7	14.2
51	50.9	2.5	111	110.9	5.4	171	170.8	8.4	231	230.7	11.3	291	290.6	14.3
52	51.9	2.6	12	111.9	5.5	72	171.8	8.4	32	231.7	11.4	92	291.6	14.3
53	52.9	2.6	13	112.9	5.5	73	172.8	8.5	33	232.7	11.4	93	292.6	14.4
54	53.9	2.6	14	113.9	5.6	74	173.8	8.5	34	233.7	11.5	94	293.6	14.4
55	54.9	2.7	15	114.9	5.6	75	174.8	8.6	35	234.7	11.5	95	294.6	14.5
56	55.9	2.7	16	115.9	5.7	76	175.8	8.6	36	235.7	11.6	96	295.6	14.5
57	56.9	2.8	17	116.9	5.7	77	176.8	8.7	37	236.7	11.6	97	296.6	14.6
58	57.9	2.8	18	117.9	5.8	78	177.8	8.7	38	237.7	11.7	98	297.6	14.6
59	58.9	2.9	19	118.9	5.8	79	178.8	8.8	39	238.7	11.7	99	298.6	14.7
60	59.9	2.9	20	119.9	5.9	80	179.8	8.8	40	239.7	11.8	300	299.6	14.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

E. ¾ N. E. ¾ S. W. ¾ N. W. ¾ S. [For 7¾ Points.

TABLE 1.

Difference of Latitude and Departure for ½ Point.

N. ½ E. N. ½ W. S. ½ E. S. ½ W.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	1.0	0.1	61	60.7	6.0	121	120.4	11.9	181	180.1	17.7	241	239.8	23.6
2	2.0	0.2	62	61.7	6.1	22	121.4	12.0	82	181.1	17.8	42	240.8	23.7
3	3.0	0.3	63	62.7	6.2	23	122.4	12.1	83	182.1	17.9	43	241.8	23.8
4	4.0	0.4	64	63.7	6.3	24	123.4	12.2	84	183.1	18.0	44	242.8	23.9
5	5.0	0.5	65	64.7	6.4	25	124.4	12.3	85	184.1	18.1	45	243.8	24.0
6	6.0	0.6	66	65.7	6.5	26	125.4	12.4	86	185.1	18.2	46	244.8	24.1
7	7.0	0.7	67	66.7	6.6	27	126.4	12.4	87	186.1	18.3	47	245.8	24.2
8	8.0	0.8	68	67.7	6.7	28	127.4	12.5	88	187.1	18.4	48	246.8	24.3
9	9.0	0.9	69	68.7	6.8	29	128.4	12.6	89	188.1	18.5	49	247.8	24.4
10	10.0	1.0	70	69.7	6.9	30	129.4	12.7	90	189.1	18.6	50	248.8	24.5
11	10.9	1.1	71	70.7	7.0	131	130.4	12.8	191	190.1	18.7	251	249.8	24.6
12	11.9	1.2	72	71.7	7.1	32	131.4	12.9	92	191.1	18.8	52	250.8	24.7
13	12.9	1.3	73	72.6	7.2	33	132.4	13.0	93	192.1	18.9	53	251.8	24.8
14	13.9	1.4	74	73.6	7.3	34	133.4	13.1	94	193.1	19.0	54	252.8	24.9
15	14.9	1.5	75	74.6	7.4	35	134.3	13.2	95	194.1	19.1	55	253.8	25.0
16	15.9	1.6	76	75.6	7.4	36	135.3	13.3	96	195.1	19.2	56	254.8	25.1
17	16.9	1.7	77	76.6	7.5	37	136.3	13.4	97	196.1	19.3	57	255.8	25.2
18	17.9	1.8	78	77.6	7.6	38	137.3	13.5	98	197.0	19.4	58	256.8	25.3
19	18.9	1.9	79	78.6	7.7	39	138.3	13.6	99	198.0	19.5	59	257.8	25.4
20	19.9	2.0	80	79.6	7.8	40	139.3	13.7	200	199.0	19.6	60	258.7	25.5
21	20.9	2.1	81	80.6	7.9	141	140.3	13.8	201	200.0	19.7	261	259.7	25.6
22	21.9	2.2	82	81.6	8.0	42	141.3	13.9	02	201.0	19.8	62	260.7	25.7
23	22.9	2.3	83	82.6	8.1	43	142.3	14.0	03	202.0	19.9	63	261.7	25.8
24	23.9	2.4	84	83.6	8.2	44	143.3	14.1	04	203.0	20.0	64	262.7	25.9
25	24.9	2.5	85	84.6	8.3	45	144.3	14.2	05	204.0	20.1	65	263.7	26.0
26	25.9	2.5	86	85.6	8.4	46	145.3	14.3	06	205.0	20.2	66	264.7	26.1
27	26.9	2.6	87	86.6	8.5	47	146.3	14.4	07	206.0	20.3	67	265.7	26.2
28	27.9	2.7	88	87.6	8.6	48	147.3	14.5	08	207.0	20.4	68	266.7	26.3
29	28.9	2.8	89	88.6	8.7	49	148.3	14.6	09	208.0	20.5	69	267.7	26.4
30	29.9	2.9	90	89.6	8.8	50	149.3	14.7	10	209.0	20.6	70	268.7	26.5
31	30.9	3.0	91	90.6	8.9	151	150.3	14.8	211	210.0	20.7	271	269.7	26.6
32	31.8	3.1	92	91.6	9.0	52	151.3	14.9	12	211.0	20.8	72	270.7	26.7
33	32.8	3.2	93	92.6	9.1	53	152.3	15.0	13	212.0	20.9	73	271.7	26.8
34	33.8	3.3	94	93.5	9.2	54	153.3	15.1	14	213.0	21.0	74	272.7	26.9
35	34.8	3.4	95	94.5	9.3	55	154.3	15.2	15	214.0	21.1	75	273.7	27.0
36	35.8	3.5	96	95.5	9.4	56	155.2	15.3	16	215.0	21.2	76	274.7	27.1
37	36.8	3.6	97	96.5	9.5	57	156.2	15.4	17	216.0	21.3	77	275.7	27.2
38	37.8	3.7	98	97.5	9.6	58	157.2	15.5	18	217.0	21.4	78	276.7	27.2
39	38.8	3.8	99	98.5	9.7	59	158.2	15.6	19	217.9	21.5	79	277.7	27.3
40	39.8	3.9	100	99.5	9.8	60	159.2	15.7	20	218.9	21.6	80	278.7	27.4
41	40.8	4.0	101	100.5	9.9	161	160.2	15.8	221	219.9	21.7	281	279.6	27.5
42	41.8	4.1	02	101.5	10.0	62	161.2	15.9	22	220.9	21.8	82	280.6	27.6
43	42.8	4.2	03	102.5	10.1	63	162.2	16.0	23	221.9	21.9	83	281.6	27.7
44	43.8	4.3	04	103.5	10.2	64	163.2	16.1	24	222.9	22.0	84	282.6	27.8
45	44.8	4.4	05	104.5	10.3	65	164.2	16.2	25	223.9	22.1	85	283.6	27.9
46	45.8	4.5	06	105.5	10.4	66	165.2	16.3	26	224.9	22.2	86	284.6	28.0
47	46.8	4.6	07	106.5	10.5	67	166.2	16.4	27	225.9	22.2	87	285.6	28.1
48	47.8	4.7	08	107.5	10.6	68	167.2	16.5	28	226.9	22.3	88	286.6	28.2
49	48.8	4.8	09	108.5	10.7	69	168.2	16.6	29	227.9	22.4	89	287.6	28.3
50	49.8	4.9	10	109.5	10.8	70	169.2	16.7	30	228.9	22.5	90	288.6	28.4
51	50.8	5.0	111	110.5	10.9	171	170.2	16.8	231	229.9	22.6	291	289.6	28.5
52	51.7	5.1	12	111.5	11.0	72	171.2	16.9	32	230.9	22.7	92	290.6	28.6
53	52.7	5.2	13	112.5	11.1	73	172.2	17.0	33	231.9	22.8	93	291.6	28.7
54	53.7	5.3	14	113.5	11.2	74	173.2	17.1	34	232.9	22.9	94	292.6	28.8
55	54.7	5.4	15	114.4	11.3	75	174.2	17.2	35	233.9	23.0	95	293.6	28.9
56	55.7	5.5	16	115.4	11.4	76	175.2	17.3	36	234.9	23.1	96	294.6	29.0
57	56.7	5.6	17	116.4	11.5	77	176.1	17.3	37	235.9	23.2	97	295.6	29.1
58	57.7	5.7	18	117.4	11.6	78	177.1	17.4	38	236.9	23.3	98	296.6	29.2
59	58.7	5.8	19	118.4	11.7	79	178.1	17.5	39	237.8	23.4	99	297.6	29.3
60	59.7	5.9	20	119.4	11.8	80	179.1	17.6	40	238.8	23.5	300	298.6	29.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

E. ½ N. E. ½ S. W. ½ N. W ½ S. [For 7½ Points.

TABLE 1.

Difference of Latitude and Departure for ¾ Point.

N. ¾ E. N. ¾ W. S. ¾ E. S. ¾ W.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	1.0	0.1	61	60.3	9.0	121	119.7	17.8	181	179.0	26.6	241	238.4	35.4
2	2.0	0.3	62	61.3	9.1	22	120.7	17.9	82	180.0	26.7	42	239.4	35.5
3	3.0	0.4	63	62.3	9.2	23	121.7	18.0	83	181.0	26.9	43	240.4	35.7
4	4.0	0.6	64	63.3	9.4	24	122.7	18.2	84	182.0	27.0	44	241.4	35.8
5	4.9	0.7	65	64.3	9.5	25	123.6	18.3	85	183.0	27.1	45	242.3	35.9
6	5.9	0.9	66	65.3	9.7	26	124.6	18.5	86	184.0	27.3	46	243.3	36.1
7	6.9	1.0	67	66.3	9.8	27	125.6	18.6	87	185.0	27.4	47	244.3	36.2
8	7.9	1.2	68	67.3	10.0	28	126.6	18.8	88	186.0	27.6	48	245.3	36.4
9	8.9	1.3	69	68.3	10.1	29	127.6	18.9	89	187.0	27.7	49	246.3	36.5
10	9.9	1.5	70	69.2	10.3	30	128.6	19.1	90	187.9	27.9	50	247.3	36.7
11	10.9	1.6	71	70.2	10.4	131	129.6	19.2	191	188.9	28.0	251	248.3	36.8
12	11.9	1.8	72	71.2	10.6	32	130.6	19.4	92	189.9	28.2	52	249.3	37.0
13	12.9	1.9	73	72.2	10.7	33	131.6	19.5	93	190.9	28.3	53	250.3	37.1
14	13.8	2.1	74	73.2	10.9	34	132.5	19.7	94	191.9	28.5	54	251.3	37.3
15	14.8	2.2	75	74.2	11.0	35	133.5	19.8	95	192.9	28.6	55	252.2	37.4
16	15.8	2.3	76	75.2	11.2	36	134.5	20.0	96	193.9	28.8	56	253.2	37.6
17	16.8	2.5	77	76.2	11.3	37	135.5	20.1	97	194.9	28.9	57	254.2	37.7
18	17.8	2.6	78	77.2	11.4	38	136.5	20.2	98	195.9	29.1	58	255.2	37.9
19	18.8	2.8	79	78.1	11.6	39	137.5	20.4	99	196.8	29.2	59	256.2	38.0
20	19.8	2.9	80	79.1	11.7	40	138.5	20.5	200	197.8	29.3	60	257.2	38.1
21	20.8	3.1	81	80.1	11.9	141	139.5	20.7	201	198.8	29.5	261	258.2	38.3
22	21.8	3.2	82	81.1	12.0	42	140.5	20.8	02	199.8	29.6	62	259.2	38.4
23	22.8	3.4	83	82.1	12.2	43	141.5	21.0	03	200.8	29.8	63	260.2	38.6
24	23.7	3.5	84	83.1	12.3	44	142.4	21.1	04	201.8	29.9	64	261.1	38.7
25	24.7	3.7	85	84.1	12.5	45	143.4	21.3	05	202.8	30.1	65	262.1	38.9
26	25.7	3.8	86	85.1	12.6	46	144.4	21.4	06	203.8	30.2	66	263.1	39.0
27	26.7	4.0	87	86.1	12.8	47	145.4	21.6	07	204.8	30.4	67	264.1	39.2
28	27.7	4.1	88	87.0	12.9	48	146.4	21.7	08	205.7	30.5	68	265.1	39.3
29	28.7	4.3	89	88.0	13.1	49	147.4	21.9	09	206.7	30.7	69	266.1	39.5
30	29.7	4.4	90	89.0	13.2	50	148.4	22.0	10	207.7	30.8	70	267.1	39.6
31	30.7	4.5	91	90.0	13.4	151	149.4	22.2	211	208.7	31.0	271	268.1	39.8
32	31.7	4.7	92	91.0	13.5	52	150.4	22.3	12	209.7	31.1	72	269.1	39.9
33	32.6	4.8	93	92.0	13.6	53	151.3	22.4	13	210.7	31.3	73	270.0	40.1
34	33.6	5.0	94	93.0	13.8	54	152.3	22.6	14	211.7	31.4	74	271.0	40.2
35	34.6	5.1	95	94.0	13.9	55	153.3	22.7	15	212.7	31.5	75	272.0	40.4
36	35.6	5.3	96	95.0	14.1	56	154.3	22.9	16	213.7	31.7	76	273.0	40.5
37	36.6	5.4	97	96.0	14.2	57	155.3	23.0	17	214.7	31.8	77	274.0	40.6
38	37.6	5.6	98	96.9	14.4	58	156.3	23.2	18	215.6	32.0	78	275.0	40.8
39	38.6	5.7	99	97.9	14.5	59	157.3	23.3	19	216.6	32.1	79	276.0	40.9
40	39.6	5.9	100	98.9	14.7	60	158.3	23.5	20	217.6	32.3	80	277.0	41.1
41	40.6	6.0	101	99.9	14.8	161	159.3	23.6	221	218.6	32.4	281	278.0	41.2
42	41.5	6.2	02	100.9	15.0	62	160.2	23.8	22	219.6	32.6	82	278.9	41.4
43	42.5	6.3	03	101.9	15.1	63	161.2	23.9	23	220.6	32.7	83	279.9	41.5
44	43.5	6.5	04	102.9	15.3	64	162.2	24.1	24	221.6	32.9	84	280.9	41.7
45	44.5	6.6	05	103.9	15.4	65	163.2	24.2	25	222.6	33.0	85	281.9	41.8
46	45.5	6.7	06	104.9	15.6	66	164.2	24.4	26	223.6	33.2	86	282.9	42.0
47	46.5	6.9	07	105.8	15.7	67	165.2	24.5	27	224.5	33.3	87	283.9	42.1
48	47.5	7.0	08	106.8	15.8	68	166.2	24.7	28	225.5	33.5	88	284.9	42.3
49	48.5	7.2	09	107.8	16.0	69	167.2	24.8	29	226.5	33.6	89	285.9	42.4
50	49.5	7.3	10	108.8	16.1	70	168.2	24.9	30	227.5	33.7	90	286.9	42.6
51	50.4	7.5	111	109.8	16.3	171	169.1	25.1	231	228.5	33.9	291	287.9	42.7
52	51.4	7.6	12	110.8	16.4	72	170.1	25.2	32	229.5	34.0	92	288.8	42.8
53	52.4	7.8	13	111.8	16.6	73	171.1	25.4	33	230.5	34.2	93	289.8	43.0
54	53.4	7.9	14	112.8	16.7	74	172.1	25.5	34	231.5	34.3	94	290.8	43.1
55	54.4	8.1	15	113.8	16.9	75	173.1	25.7	35	232.5	34.5	95	291.8	43.3
56	55.4	8.2	16	114.7	17.0	76	174.1	25.8	36	233.4	34.6	96	292.8	43.4
57	56.4	8.4	17	115.7	17.2	77	175.1	26.0	37	234.4	34.8	97	293.8	43.6
58	57.4	8.5	18	116.7	17.3	78	176.1	26.1	38	235.4	34.9	98	294.8	43.7
59	58.4	8.7	19	117.7	17.5	79	177.1	26.3	39	236.4	35.1	99	295.8	43.9
60	59.4	8.8	20	118.7	17.6	80	178.1	26.4	40	237.4	35.2	300	296.8	44.0
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

E. ¾ N. E. ¾ S. W. ¾ N. W. ¾ S. [For 7¼ Points.

TABLE 1.

Difference of Latitude and Departure for 1 Point.

N. by E. N. by W. S. by E. S. by W.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	1.0	0.2	61	59.8	11.9	121	118.7	23.6	181	177.5	35.3	241	236.4	47.0
2	2.0	0.4	62	60.8	12.1	22	119.7	23.8	82	178.5	35.5	42	237.4	47.2
3	2.9	0.6	63	61.8	12.3	23	120.6	24.0	83	179.5	35.7	43	238.3	47.4
4	3.9	0.8	64	62.8	12.5	24	121.6	24.2	84	180.5	35.9	44	239.3	47.6
5	4.9	1.0	65	63.8	12.7	25	122.6	24.4	85	181.4	36.1	45	240.3	47.8
6	5.9	1.2	66	64.7	12.9	26	123.6	24.6	86	182.4	36.3	46	241.3	48.0
7	6.9	1.4	67	65.7	13.1	27	124.6	24.8	87	183.4	36.5	47	242.3	48.2
8	7.8	1.6	68	66.7	13.3	28	125.5	25.0	88	184.4	36.7	48	243.2	48.4
9	8.8	1.8	69	67.7	13.5	29	126.5	25.2	89	185.4	36.9	49	244.2	48.6
10	9.8	2.0	70	68.7	13.7	30	127.5	25.4	90	186.3	37.1	50	245.2	48.8
11	10.8	2.1	71	69.6	13.9	131	128.5	25.6	191	187.3	37.3	251	246.2	49.0
12	11.8	2.3	72	70.6	14.0	32	129.5	25.8	92	188.3	37.5	52	247.2	49.2
13	12.8	2.5	73	71.6	14.2	33	130.4	25.9	93	189.3	37.7	53	248.1	49.4
14	13.7	2.7	74	72.6	14.4	34	131.4	26.1	94	190.3	37.8	54	249.1	49.6
15	14.7	2.9	75	73.6	14.6	35	132.4	26.3	95	191.3	38.0	55	250.1	49.7
16	15.7	3.1	76	74.5	14.8	36	133.4	26.5	96	192.2	38.2	56	251.1	49.9
17	16.7	3.3	77	75.5	15.0	37	134.4	26.7	97	193.2	38.4	57	252.1	50.1
18	17.7	3.5	78	76.5	15.2	38	135.3	26.9	98	194.2	38.6	58	253.0	50.3
19	18.6	3.7	79	77.5	15.4	39	136.3	27.1	99	195.2	38.8	59	254.0	50.5
20	19.6	3.9	80	78.5	15.6	40	137.3	27.3	200	196.2	39.0	60	255.0	50.7
21	20.6	4.1	81	79.4	15.8	141	138.3	27.5	201	197.1	39.2	261	256.0	50.9
22	21.6	4.3	82	80.4	16.0	42	139.3	27.7	02	198.1	39.4	62	257.0	51.1
23	22.6	4.5	83	81.4	16.2	43	140.3	27.9	03	199.1	39.6	63	257.9	51.3
24	23.5	4.7	84	82.4	16.4	44	141.2	28.1	04	200.1	39.8	64	258.9	51.5
25	24.5	4.9	85	83.4	16.6	45	142.2	28.3	05	201.1	40.0	65	259.9	51.7
26	25.5	5.1	86	84.3	16.8	46	143.2	28.5	06	202.0	40.2	66	260.9	51.9
27	26.5	5.3	87	85.3	17.0	47	144.2	28.7	07	203.0	40.4	67	261.9	52.1
28	27.5	5.5	88	86.3	17.2	48	145.2	28.9	08	204.0	40.6	68	262.9	52.3
29	28.4	5.7	89	87.3	17.4	49	146.1	29.1	09	205.0	40.8	69	263.8	52.5
30	29.4	5.9	90	88.3	17.6	50	147.1	29.3	10	206.0	41.0	70	264.8	52.7
31	30.4	6.0	91	89.3	17.8	151	148.1	29.5	211	206.9	41.2	271	265.8	52.9
32	31.4	6.2	92	90.2	17.9	52	149.1	29.7	12	207.9	41.4	72	266.8	53.1
33	32.4	6.4	93	91.2	18.1	53	150.1	29.8	13	208.9	41.6	73	267.8	53.3
34	33.3	6.6	94	92.2	18.3	54	151.0	30.0	14	209.9	41.7	74	268.7	53.5
35	34.3	6.8	95	93.2	18.5	55	152.0	30.2	15	210.9	41.9	75	269.7	53.6
36	35.3	7.0	96	94.2	18.7	56	153.0	30.4	16	211.8	42.1	76	270.7	53.8
37	36.3	7.2	97	95.1	18.9	57	154.0	30.6	17	212.8	42.3	77	271.7	54.0
38	37.3	7.4	98	96.1	19.1	58	155.0	30.8	18	213.8	42.5	78	272.7	54.2
39	38.3	7.6	99	97.1	19.3	59	155.9	31.0	19	214.8	42.7	79	273.6	54.4
40	39.2	7.8	100	98.1	19.5	60	156.9	31.2	20	215.8	42.9	80	274.6	54.6
41	40.2	8.0	101	99.1	19.7	161	157.9	31.4	221	216.8	43.1	281	275.6	54.8
42	41.2	8.2	02	100.0	19.9	62	158.9	31.6	22	217.7	43.3	82	276.6	55.0
43	42.2	8.4	03	101.0	20.1	63	159.9	31.8	23	218.7	43.5	83	277.6	55.2
44	43.2	8.6	04	102.0	20.3	64	160.8	32.0	24	219.7	43.7	84	278.5	55.4
45	44.1	8.8	05	103.0	20.5	65	161.8	32.2	25	220.7	43.9	85	279.5	55.6
46	45.1	9.0	06	104.0	20.7	66	162.8	32.4	26	221.7	44.1	86	280.5	55.8
47	46.1	9.2	07	104.9	20.9	67	163.8	32.6	27	222.6	44.3	87	281.5	56.0
48	47.1	9.4	08	105.9	21.1	68	164.8	32.8	28	223.6	44.5	88	282.5	56.2
49	48.1	9.6	09	106.9	21.3	69	165.8	33.0	29	224.6	44.7	89	283.4	56.4
50	49.0	9.8	10	107.9	21.5	70	166.7	33.2	30	225.6	44.9	90	284.4	56.6
51	50.0	9.9	111	108.9	21.7	171	167.7	33.4	231	226.6	45.1	291	285.4	56.8
52	51.0	10.1	12	109.8	21.9	72	168.7	33.6	32	227.5	45.3	92	286.4	57.0
53	52.0	10.3	13	110.8	22.0	73	169.7	33.8	33	228.5	45.5	93	287.4	57.2
54	53.0	10.5	14	111.8	22.2	74	170.7	33.9	34	229.5	45.7	94	288.4	57.4
55	53.9	10.7	15	112.8	22.4	75	171.6	34.1	35	230.5	45.8	95	289.3	57.6
56	54.9	10.9	16	113.8	22.6	76	172.6	34.3	36	231.5	46.0	96	290.3	57.7
57	55.9	11.1	17	114.8	22.8	77	173.6	34.5	37	232.4	46.2	97	291.3	57.9
58	56.9	11.3	18	115.7	23.0	78	174.6	34.7	38	233.4	46.4	98	292.3	58.1
59	57.9	11.5	19	116.7	23.2	79	175.6	34.9	39	234.4	46.6	99	293.3	58.3
60	58.8	11.7	20	117.7	23.4	80	176.5	35.1	40	235.4	46.8	300	294.2	58.5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

E. by N. E. by S. W. by N. W. by S. [For 7 points.

TABLE 1.

Difference of Latitude and Departure for 1¼ Points.

N. by E. ¼ E. N. by W. ¼ W. S. by E. ¼ E. S. by W. ¼ W.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	1.0	0.2	61	59.2	14.8	121	117.4	29.4	181	175.6	44.0	241	233.8	58.6
2	1.9	0.5	62	60.1	15.1	22	118.3	29.6	82	176.5	44.2	42	234.7	58.8
3	2.9	0.7	63	61.1	15.3	23	119.3	29.9	83	177.5	44.5	43	235.7	59.0
4	3.9	1.0	64	62.1	15.6	24	120.3	30.1	84	178.5	44.7	44	236.7	59.3
5	4.9	1.2	65	63.1	15.8	25	121.3	30.4	85	179.5	45.0	45	237.7	59.5
6	5.8	1.5	66	64.0	16.0	26	122.2	30.6	86	180.4	45.2	46	238.6	59.8
7	6.8	1.7	67	65.0	16.3	27	123.2	30.9	87	181.4	45.4	47	239.6	60.0
8	7.8	1.9	68	66.0	16.5	28	124.2	31.1	88	182.4	45.7	48	240.6	60.3
9	8.7	2.2	69	66.9	16.8	29	125.1	31.3	89	183.3	45.9	49	241.5	60.5
10	9.7	2.4	70	67.9	17.0	30	126.1	31.6	90	184.3	46.2	50	242.5	60.7
11	10.7	2.7	71	68.9	17.3	131	127.1	31.8	191	185.3	46.4	251	243.5	61.0
12	11.6	2.9	72	69.8	17.5	32	128.0	32.1	92	186.2	46.7	52	244.4	61.2
13	12.6	3.2	73	70.8	17.7	33	129.0	32.3	93	187.2	46.9	53	245.4	61.5
14	13.6	3.4	74	71.8	18.0	34	130.0	32.6	94	188.2	47.1	54	246.4	61.7
15	14.6	3.6	75	72.8	18.2	35	131.0	32.8	95	189.2	47.4	55	247.4	62.0
16	15.5	3.9	76	73.7	18.5	36	131.9	33.0	96	190.1	47.6	56	248.3	62.2
17	16.5	4.1	77	74.7	18.7	37	132.9	33.3	97	191.1	47.9	57	249.3	62.4
18	17.5	4.4	78	75.7	19.0	38	133.9	33.5	98	192.1	48.1	58	250.3	62.7
19	18.4	4.6	79	76.6	19.2	39	134.8	33.8	99	193.0	48.4	59	251.2	62.9
20	19.4	4.9	80	77.6	19.4	40	135.8	34.0	200	194.0	48.6	60	252.2	63.2
21	20.4	5.1	81	78.6	19.7	141	136.8	34.3	201	195.0	48.8	261	253.2	63.4
22	21.3	5.3	82	79.5	19.9	42	137.7	34.5	02	195.9	49.1	62	254.1	63.7
23	22.3	5.6	83	80.5	20.2	43	138.7	34.7	03	196.9	49.3	63	255.1	63.9
24	23.3	5.8	84	81.5	20.4	44	139.7	35.0	04	197.9	49.6	64	256.1	64.1
25	24.3	6.1	85	82.5	20.7	45	140.7	35.2	05	198.9	49.8	65	257.1	64.4
26	25.2	6.3	86	83.4	20.9	46	141.6	35.5	06	199.8	50.1	66	258.0	64.6
27	26.2	6.6	87	84.4	21.1	47	142.6	35.7	07	200.8	50.3	67	259.0	64.9
28	27.2	6.8	88	85.4	21.4	48	143.6	36.0	08	201.8	50.5	68	260.0	65.1
29	28.1	7.0	89	86.3	21.6	49	144.5	36.2	09	202.7	50.8	69	260.9	65.4
30	29.1	7.3	90	87.3	21.9	50	145.5	36.4	10	203.7	51.0	70	261.9	65.6
31	30.1	7.5	91	88.3	22.1	151	146.5	36.7	211	204.7	51.3	271	262.9	65.8
32	31.0	7.8	92	89.2	22.4	52	147.4	36.9	12	205.6	51.5	72	263.8	66.1
33	32.0	8.0	93	90.2	22.6	53	148.4	37.2	13	206.6	51.8	73	264.8	66.3
34	33.0	8.3	94	91.2	22.8	54	149.4	37.4	14	207.6	52.0	74	265.8	66.6
35	34.0	8.5	95	92.2	23.1	55	150.4	37.7	15	208.6	52.2	75	266.8	66.8
36	34.9	8.7	96	93.1	23.3	56	151.3	37.9	16	209.5	52.5	76	267.7	67.1
37	35.9	9.0	97	94.1	23.6	57	152.3	38.1	17	210.5	52.7	77	268.7	67.3
38	36.9	9.2	98	95.1	23.8	58	153.3	38.4	18	211.5	53.0	78	269.7	67.5
39	37.8	9.5	99	96.0	24.1	59	154.2	38.6	19	212.4	53.2	79	270.6	67.8
40	38.8	9.7	100	97.0	24.3	60	155.2	38.9	20	213.4	53.5	80	271.6	68.0
41	39.8	10.0	101	98.0	24.5	161	156.2	39.1	221	214.4	53.7	281	272.6	68.3
42	40.7	10.2	02	98.9	24.8	62	157.1	39.4	22	215.3	53.9	82	273.5	68.5
43	41.7	10.4	03	99.9	25.0	63	158.1	39.6	23	216.3	54.2	83	274.5	68.8
44	42.7	10.7	04	100.9	25.3	64	159.1	39.8	24	217.3	54.4	84	275.5	69.0
45	43.7	10.9	05	101.9	25.5	65	160.1	40.1	25	218.3	54.7	85	277.5	69.2
46	44.6	11.2	06	102.8	25.8	66	161.0	40.3	26	219.2	54.9	86	277.4	69.5
47	45.6	11.4	07	103.8	26.0	67	162.0	40.6	27	220.2	55.2	87	278.4	69.7
48	46.6	11.7	08	104.8	26.2	68	163.0	40.8	28	221.2	55.4	88	279.4	70.0
49	47.5	11.9	09	105.7	26.5	69	163.9	41.1	29	222.1	55.6	89	280.3	70.2
50	48.5	12.1	10	106.7	26.7	70	164.9	41.3	30	223.1	55.9	90	281.3	70.5
51	49.5	12.4	111	107.7	27.0	171	165.9	41.5	231	224.1	56.1	291	282.3	70.7
52	50.4	12.6	12	108.6	27.2	72	166.8	41.8	32	225.0	56.4	92	283.2	71.0
53	51.4	12.9	13	109.6	27.5	73	167.8	42.0	33	226.0	56.6	93	284.2	71.2
54	52.4	13.1	14	110.6	27.7	74	168.8	42.3	34	227.0	56.9	94	285.2	71.4
55	53.4	13.4	15	111.6	27.9	75	169.8	42.5	35	228.0	57.1	95	286.2	71.7
56	54.3	13.6	16	112.5	28.2	76	170.7	42.8	36	228.9	57.3	96	287.1	71.9
57	55.3	13.8	17	113.5	28.4	77	171.7	43.0	37	229.9	57.6	97	288.1	72.2
58	56.3	14.1	18	114.5	28.7	78	172.7	43.3	38	230.9	57.8	98	289.1	72.4
59	57.2	14.3	19	115.4	28.9	79	173.6	43.5	39	231.8	58.1	99	290.9	72.7
60	58.2	14.6	20	116.4	29.2	80	174.6	43.7	40	232.8	58.3	300	291.0	72.9
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

ENE. ¾ E. ESE. ¾ E. WNW. ¾ W. WSW. ¾ W. [For 6¾ Points.

TABLE 1.

Difference of Latitude and Departure for 1½ Points.

N. by E. ½ E. N. by W. ½ W. S. by E. ½ E. S. by W. ½ W.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	1.0	0.3	61	58.4	17.7	121	115.8	35.1	181	173.2	52.5	241	230.6	70.0
2	1.9	0.6	62	59.3	18.0	22	116.7	35.4	82	174.2	52.8	42	231.6	70.2
3	2.9	0.9	63	60.3	18.3	23	117.7	35.7	83	175.1	53.1	43	232.5	70.5
4	3.8	1.2	64	61.2	18.6	24	118.7	36.0	84	176.1	53.4	44	233.5	70.8
5	4.8	1.5	65	62.2	18.9	25	119.6	36.3	85	177.0	53.7	45	234.5	71.1
6	5.7	1.7	66	63.2	19.2	26	120.6	36.6	86	178.0	54.0	46	235.4	71.4
7	6.7	2.0	67	64.1	19.4	27	121.5	36.9	87	178.9	54.3	47	236.4	71.7
8	7.7	2.3	68	65.1	19.7	28	122.5	37.2	88	179.9	54.6	48	237.3	72.0
9	8.6	2.6	69	66.0	20.0	29	123.4	37.4	89	180.9	54.9	49	238.3	72.3
10	9.6	2.9	70	67.0	20.3	30	124.4	37.7	90	181.8	55.2	50	239.2	72.6
11	10.5	3.2	71	67.9	20.6	131	125.4	38.0	191	182.8	55.4	251	240.2	72.9
12	11.5	3.5	72	68.9	20.9	32	126.3	38.3	92	183.7	55.7	52	241.1	73.2
13	12.4	3.8	73	69.9	21.2	33	127.3	38.6	93	184.7	56.0	53	242.1	73.4
14	13.4	4.1	74	70.8	21.5	34	128.2	38.9	94	185.6	56.3	54	243.1	73.7
15	14.4	4.4	75	71.8	21.8	35	129.2	39.2	95	186.6	56.6	55	244.0	74.0
16	15.3	4.6	76	72.7	22.1	36	130.1	39.5	96	187.6	56.9	56	245.0	74.3
17	16.3	4.9	77	73.7	22.4	37	131.1	39.8	97	188.5	57.2	57	245.9	74.6
18	17.2	5.2	78	74.6	22.6	38	132.1	40.1	98	189.5	57.5	58	246.9	74.9
19	18.2	5.5	79	75.6	22.9	39	133.0	40.3	99	190.4	57.8	59	247.8	75.2
20	19.1	5.8	80	76.6	23.2	40	134.0	40.6	200	191.4	58.1	60	248.8	75.5
21	20.1	6.1	81	77.5	23.5	141	134.9	40.9	201	192.3	58.3	261	249.8	75.8
22	21.1	6.4	82	78.5	23.8	42	135.9	41.2	02	193.3	58.6	62	250.7	76.1
23	22.0	6.7	83	79.4	24.1	43	136.8	41.5	03	194.3	58.9	63	251.7	76.3
24	23.0	7.0	84	80.4	24.4	44	137.8	41.8	04	195.2	59.2	64	252.6	76.6
25	23.9	7.3	85	81.3	24.7	45	138.8	42.1	05	196.2	59.5	65	253.6	76.9
26	24.9	7.5	86	82.3	25.0	46	139.7	42.4	06	197.1	59.8	66	254.5	77.2
27	25.8	7.8	87	83.3	25.3	47	140.7	42.7	07	198.1	60.1	67	255.5	77.5
28	26.8	8.1	88	84.2	25.5	48	141.6	43.0	08	199.0	60.4	68	256.5	77.8
29	27.8	8.4	89	85.2	25.8	49	142.6	43.3	09	200.0	60.7	69	257.4	78.1
30	28.7	8.7	90	86.1	26.1	50	143.5	43.5	10	201.0	61.0	70	258.4	78.4
31	29.7	9.0	91	87.1	26.4	151	144.5	43.8	211	201.9	61.3	271	259.3	78.7
32	30.6	9.3	92	88.0	26.7	52	145.5	44.1	12	202.9	61.5	72	260.3	79.0
33	31.6	9.6	93	89.0	27.0	53	146.4	44.4	13	203.8	61.8	73	261.2	79.2
34	32.5	9.9	94	90.0	27.3	54	147.4	44.7	14	204.8	62.1	74	262.2	79.5
35	33.5	10.2	95	90.9	27.6	55	148.3	45.0	15	205.7	62.4	75	263.2	79.8
36	34.4	10.5	96	91.9	27.9	56	149.3	45.3	16	206.7	62.7	76	264.1	80.1
37	35.4	10.7	97	92.8	28.2	57	150.2	45.6	17	207.7	63.0	77	265.1	80.4
38	36.4	11.0	98	93.8	28.4	58	151.2	45.9	18	208.6	63.3	78	266.0	80.7
39	37.3	11.3	99	94.7	28.7	59	152.2	46.2	19	209.6	63.6	79	267.0	81.0
40	38.3	11.6	100	95.7	29.0	60	153.1	46.4	20	210.5	63.9	80	267.9	81.3
41	39.2	11.9	101	96.7	29.3	161	154.1	46.7	221	211.5	64.2	281	268.9	81.6
42	40.2	12.2	02	97.6	29.6	62	155.0	47.0	22	212.4	64.4	82	269.9	81.9
43	41.1	12.5	03	98.6	29.9	63	156.0	47.3	23	213.4	64.7	83	270.8	82.2
44	42.1	12.8	04	99.5	30.2	64	156.9	47.6	24	214.4	65.0	84	271.8	82.4
45	43.1	13.1	05	100.5	30.5	65	157.9	47.9	25	215.3	65.3	85	272.7	82.7
46	44.0	13.4	06	101.4	30.8	66	158.9	48.2	26	216.3	65.6	86	273.7	83.0
47	45.0	13.6	07	102.4	31.1	67	159.8	48.5	27	217.2	65.9	87	274.6	83.3
48	45.9	13.9	08	103.3	31.4	68	160.8	48.8	28	218.2	66.2	88	275.6	83.6
49	46.9	14.2	09	104.3	31.6	69	161.7	49.1	29	219.1	66.5	89	276.6	83.9
50	47.8	14.5	10	105.3	31.9	70	162.7	49.3	30	220.1	66.8	90	277.5	84.2
51	48.8	14.8	111	106.2	32.2	171	163.6	49.6	231	221.1	67.1	291	278.5	84.5
52	49.8	15.1	12	107.2	32.5	72	164.6	49.9	32	222.0	67.3	92	279.4	84.8
53	50.7	15.4	13	108.1	32.8	73	165.6	50.2	33	223.0	67.6	93	280.4	85.1
54	51.7	15.7	14	109.1	33.1	74	166.5	50.5	34	223.9	67.9	94	281.3	85.3
55	52.6	16.0	15	110.0	33.4	75	167.5	50.8	35	224.9	68.2	95	282.3	85.6
56	53.6	16.3	16	111.0	33.7	76	168.4	51.1	36	225.8	68.5	96	283.3	85.9
57	54.5	16.5	17	112.0	34.0	77	169.4	51.4	37	226.8	68.8	97	284.2	86.2
58	55.5	16.8	18	112.9	34.3	78	170.3	51.7	38	227.8	69.1	98	285.2	86.5
59	56.5	17.1	19	113.9	34.5	79	171.3	52.0	39	228.7	69.4	99	286.1	86.8
60	57.4	17.4	20	114.8	34.8	80	172.2	52.3	40	229.7	69.7	300	287.1	87.1
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

ENE. ½ E. ESE. ½ E. WNW. ½ W. WSW. ½ W. [For 6½ Points.

TABLE 1.

Difference of Latitude and Departure for 1¾ Points.

N. by E. ¾ E. N. by W. ¾ W. S. by E. ¾ E. S. by W. ¾ W.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	0.9	0.3	61	57.4	20.6	121	113.9	40.8	181	170.4	61.0	241	226.9	81.2
2	1.9	0.7	62	58.4	20.9	22	114.9	41.1	82	171.4	61.3	42	227.9	81.5
3	2.8	1.0	63	59.3	21.2	23	115.8	41.4	83	172.3	61.7	43	228.8	81.9
4	3.8	1.3	64	60.3	21.6	24	116.8	41.8	84	173.2	62.0	44	229.7	82.2
5	4.7	1.7	65	61.2	21.9	25	117.7	42.1	85	174.2	62.3	45	230.7	82.5
6	5.6	2.0	66	62.1	22.2	26	118.6	42.4	86	175.1	62.7	46	231.6	82.9
7	6.6	2.4	67	63.1	22.6	27	119.6	42.8	87	176.1	63.0	47	232.6	83.2
8	7.5	2.7	68	64.0	22.9	28	120.5	43.1	88	177.0	63.3	48	233.5	83.5
9	8.5	3.0	69	65.0	23.2	29	121.5	43.5	89	178.0	63.7	49	234.4	83.9
10	9.4	3.4	70	65.9	23.6	30	122.4	43.8	90	178.9	64.0	50	235.4	84.2
11	10.4	3.7	71	66.8	23.9	131	123.3	44.1	191	179.8	64.3	251	236.3	84.6
12	11.3	4.0	72	67.8	24.3	32	124.3	44.5	92	180.8	64.7	52	237.3	84.9
13	12.2	4.4	73	68.7	24.6	33	125.2	44.8	93	181.7	65.0	53	238.2	85.2
14	13.2	4.7	74	69.7	24.9	34	126.2	45.1	94	182.7	65.4	54	239.2	85.6
15	14.1	5.1	75	70.6	25.3	35	127.1	45.5	95	183.6	65.7	55	240.1	85.9
16	15.1	5.4	76	71.6	25.6	36	128.0	45.8	96	184.5	66.0	56	241.0	86.2
17	16.0	5.7	77	72.5	25.9	37	129.0	46.2	97	185.5	66.4	57	242.0	86.6
18	16.9	6.1	78	73.4	26.3	38	129.9	46.5	98	186.4	66.7	58	242.9	86.9
19	17.9	6.4	79	74.4	26.6	39	130.9	46.8	99	187.4	67.0	59	243.9	87.3
20	18.8	6.7	80	75.3	27.0	40	131.8	47.2	200	188.3	67.4	60	244.8	87.6
21	19.8	7.1	81	76.3	27.3	141	132.8	47.5	201	189.3	67.7	261	245.7	87.9
22	20.7	7.4	82	77.2	27.6	42	133.7	47.8	02	190.2	68.1	62	246.7	88.3
23	21.7	7.7	83	78.1	28.0	43	134.6	48.2	03	191.1	68.4	63	247.6	88.6
24	22.6	8.1	84	79.1	28.3	44	135.6	48.5	04	192.1	68.7	64	248.6	88.9
25	23.5	8.4	85	80.0	28.6	45	136.5	48.8	05	193.0	69.1	65	249.5	89.3
26	24.5	8.8	86	81.0	29.0	46	137.5	49.2	06	194.0	69.4	66	250.5	89.6
27	25.4	9.1	87	81.9	29.3	47	138.4	49.5	07	194.9	69.7	67	251.4	89.9
28	26.4	9.4	88	82.9	29.6	48	139.3	49.9	08	195.8	70.1	68	252.3	90.3
29	27.3	9.8	89	83.8	30.0	49	140.3	50.2	09	196.8	70.4	69	253.3	90.6
30	28.2	10.1	90	84.7	30.3	50	141.2	50.5	10	197.7	70.7	70	254.2	91.0
31	29.2	10.4	91	85.7	30.7	151	142.2	50.9	211	198.7	71.1	271	255.2	91.3
32	30.1	10.8	92	86.6	31.0	52	143.1	51.2	12	199.6	71.4	72	256.1	91.6
33	31.1	11.1	93	87.6	31.3	53	144.1	51.5	13	200.5	71.8	73	257.0	92.0
34	32.0	11.5	94	88.5	31.7	54	145.0	51.9	14	201.5	72.1	74	258.0	92.3
35	33.0	11.8	95	89.4	32.0	55	145.9	52.2	15	202.4	72.4	75	258.9	92.6
36	33.9	12.1	96	90.4	32.3	56	146.9	52.6	16	203.4	72.8	76	259.9	93.0
37	34.8	12.5	97	91.3	32.7	57	147.8	52.9	17	204.3	73.1	77	260.8	93.3
38	35.8	12.8	98	92.3	33.0	58	148.8	53.2	18	205.3	73.4	78	261.7	93.7
39	36.7	13.1	99	93.2	33.4	59	149.7	53.6	19	206.2	73.8	79	262.7	94.0
40	37.7	13.5	100	94.2	33.7	60	150.6	53.9	20	207.1	74.1	80	263.6	94.3
41	38.6	13.8	101	95.1	34.0	161	151.6	54.2	221	208.1	74.5	281	264.6	94.7
42	39.5	14.1	02	96.0	34.4	62	152.5	54.6	22	209.0	74.8	82	265.5	95.0
43	40.5	14.5	03	97.0	34.7	63	153.5	54.9	23	210.0	75.1	83	266.5	95.3
44	41.4	14.8	04	97.9	35.0	64	154.4	55.2	24	210.9	75.5	84	267.4	95.7
45	42.4	15.2	05	98.9	35.4	65	155.4	55.6	25	211.8	75.8	85	268.3	96.0
46	43.3	15.5	06	99.8	35.7	66	156.3	55.9	26	212.8	76.1	86	269.3	96.4
47	44.3	15.8	07	100.7	36.0	67	157.2	56.3	27	213.7	76.5	87	270.2	96.7
48	45.2	16.2	08	101.7	36.4	68	158.2	56.6	28	214.7	76.8	88	271.2	97.0
49	46.1	16.5	09	102.6	36.7	69	159.1	56.9	29	215.6	77.1	89	272.1	97.4
50	47.1	16.8	10	103.6	37.1	70	160.1	57.3	30	216.6	77.5	90	273.0	97.7
51	48.0	17.2	111	104.5	37.4	171	161.0	57.6	231	217.5	77.8	291	274.0	98.0
52	49.0	17.5	12	105.5	37.7	72	161.9	57.9	32	218.4	78.2	92	274.9	98.4
53	49.9	17.9	13	106.4	38.1	73	162.9	58.3	33	219.4	78.5	93	275.9	98.7
54	50.8	18.2	14	107.3	38.4	74	163.8	58.6	34	220.3	78.8	94	276.8	99.0
55	51.8	18.5	15	108.3	38.7	75	164.8	59.0	35	221.3	79.2	95	277.8	99.4
56	52.7	18.9	16	109.2	39.1	76	165.7	59.3	36	222.2	79.5	96	278.7	99.7
57	53.7	19.2	17	110.2	39.4	77	166.7	59.6	37	223.1	79.8	97	279.6	100.1
58	54.6	19.5	18	111.1	39.8	78	167.6	60.0	38	224.1	80.2	98	280.6	100.4
59	55.6	19.9	19	112.0	40.1	79	168.5	60.3	39	225.0	80.5	99	281.5	100.7
60	56.5	20.2	20	113.0	40.4	80	169.5	60.6	40	226.0	80.9	300	282.5	101.1
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

ENE. ¼ E. ESE. ¼ E. WNW. ¼ W. WSW. ¼ W. [For 6¼ Points.

TABLE 1.

Difference of Latitude and Departure for 2 Points.

NNE. NNW. SSE. SSW.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	0.9	0.4	61	56.4	23.3	121	111.8	46.3	181	167.2	69.3	241	222.7	92.2
2	1.8	0.8	62	57.3	23.7	22	112.7	46.7	82	168.1	69.6	42	223.6	92.6
3	2.8	1.1	63	58.2	24.1	23	113.6	47.1	83	169.1	70.0	43	224.5	93.0
4	3.7	1.5	64	59.1	24.5	24	114.6	47.5	84	170.0	70.4	44	225.4	93.4
5	4.6	1.9	65	60.1	24.9	25	115.5	47.8	85	170.9	70.8	45	226.4	93.8
6	5.5	2.3	66	61.0	25.3	26	116.4	48.2	86	171.8	71.2	46	227.3	94.1
7	6.5	2.7	67	61.9	25.6	27	117.3	48.6	87	172.8	71.6	47	228.2	94.5
8	7.4	3.1	68	62.8	26.0	28	118.3	49.0	88	173.7	71.9	48	229.1	94.9
9	8.3	3.4	69	63.7	26.4	29	119.2	49.4	89	174.6	72.3	49	230.0	95.3
10	9.2	3.8	70	64.7	26.8	30	120.1	49.7	90	175.5	72.7	50	231.0	95.7
11	10.2	4.2	71	65.6	27.2	131	121.0	50.1	191	176.5	73.1	251	231.9	96.1
12	11.1	4.6	72	66.5	27.6	32	122.0	50.5	92	177.4	73.5	52	232.8	96.4
13	12.0	5.0	73	67.4	27.9	33	122.9	50.9	93	178.3	73.9	53	233.7	96.8
14	12.9	5.4	74	68.4	28.3	34	123.8	51.3	94	179.2	74.2	54	234.7	97.2
15	13.9	5.7	75	69.3	28.7	35	124.7	51.7	95	180.2	74.6	55	235.6	97.6
16	14.8	6.1	76	70.2	29.1	36	125.6	52.0	96	181.1	75.0	56	236.5	98.0
17	15.7	6.5	77	71.1	29.5	37	126.6	52.4	97	182.0	75.4	57	237.4	98.3
18	16.6	6.9	78	72.1	29.8	38	127.5	52.8	98	182.9	75.8	58	238.4	98.7
19	17.6	7.3	79	73.0	30.2	39	128.4	53.2	99	183.9	76.2	59	239.3	99.1
20	18.5	7.7	80	73.9	30.6	40	129.3	53.6	200	184.8	76.5	60	240.2	99.5
21	19.4	8.0	81	74.8	31.0	141	130.3	54.0	201	185.7	76.9	261	241.1	99.9
22	20.3	8.4	82	75.8	31.4	42	131.2	54.3	02	186.6	77.3	62	242.1	100.3
23	21.2	8.8	83	76.7	31.8	43	132.1	54.7	03	187.5	77.7	63	243.0	100.6
24	22.2	9.2	84	77.6	32.1	44	133.0	55.1	04	188.5	78.1	64	243.9	101.0
25	23.1	9.6	85	78.5	32.5	45	134.0	55.5	05	189.4	78.5	65	244.8	101.4
26	24.0	9.9	86	79.5	32.9	46	134.9	55.9	06	190.3	78.8	66	245.8	101.8
27	24.9	10.3	87	80.4	33.3	47	135.8	56.3	07	191.2	79.2	67	246.7	102.2
28	25.9	10.7	88	81.3	33.7	48	136.7	56.6	08	192.2	79.6	68	247.6	102.6
29	26.8	11.1	89	82.2	34.1	49	137.7	57.0	09	193.1	80.0	69	248.5	102.9
30	27.7	11.5	90	83.1	34.4	50	138.6	57.4	10	194.0	80.4	70	249.4	103.3
31	28.6	11.9	91	84.1	34.8	151	139.5	57.8	211	194.9	80.7	271	250.4	103.7
32	29.6	12.2	92	85.0	35.2	52	140.4	58.2	12	195.9	81.1	72	251.3	104.1
33	30.5	12.6	93	85.9	35.6	53	141.4	58.6	13	196.8	81,5	73	252.2	104.5
34	31.4	13.0	94	86.8	36.0	54	142.3	58.9	14	197.7	81.9	74	253.1	104.9
35	32.3	13.4	95	87.8	36.4	55	143.2	59.3	15	198.6	82.3	75	254.1	105.2
36	33.3	13.8	96	88.7	36.7	56	144.1	59.7	16	199.6	82.7	76	255.0	105.6
37	34.2	14.2	97	89.6	37.1	57	145.0	60.1	17	200.5	83.0	77	255.9	106.0
38	35.1	14.5	98	90.5	37.5	58	146.0	60.5	18	201.4	83.4	78	256.8	106.4
39	36.0	14.9	99	91.5	37.9	59	146.9	60.8	19	202.3	83.8	79	257.8	106.8
40	37.0	15.3	100	92.4	38.3	60	147.8	61.2	20	203.3	84.2	80	258.7	107.2
41	37.9	15.7	101	93.3	38.7	161	148.7	61.6	221	204.2	84.6	281	259.6	107.5
42	38.8	16.1	02	94.2	39.0	62	149.7	62.0	22	205.1	85.0	82	260.5	107.9
43	39.7	16.5	03	95.2	39.4	63	150.6	62.4	23	206.0	85.3	83	261.5	108.3
44	40.7	16.8	04	96.1	39.8	64	151.5	62.8	24	206.9	85.7	84	262.4	108.7
45	41.6	17.2	05	97.0	40.2	65	152.4	63.1	25	207.9	86.1	85	263.3	109.1
46	42.5	17.6	06	97.9	40.6	66	153.4	63.5	26	208.8	86.5	86	264.2	109.4
47	43.4	18.0	07	98.9	40.9	67	154.3	63.9	27	209.7	86.9	87	265.2	109.8
48	44.3	18.4	08	99.8	41.3	68	155.2	64.3	28	210.6	87.3	88	266.1	110.2
49	45.3	18.8	09	100.7	41.7	69	156.1	64.7	29	211.6	87.6	89	267.0	110.6
50	46.2	19.1	10	101.6	42.1	70	157.1	65.1	30	212.5	88.0	90	267.9	111.0
51	47.1	19.5	111	102.6	42.5	171	158.0	65.4	231	213.4	88.4	291	268.8	111.4
52	48.0	19.9	12	103.5	42.9	72	158.9	65.8	32	214.3	88.8	92	269.8	111.7
53	49.0	20.3	13	104.4	43.2	73	159.8	66.2	33	215.3	89.2	93	270.7	112.1
54	49.9	20.7	14	105.3	43.6	74	160.8	66.6	34	216.2	89.5	94	271.6	112.5
55	50.8	21.0	15	106.2	44.0	75	161.7	67.0	35	217.1	89.9	95	272.5	112.9
56	51.7	21.4	16	107.2	44.4	76	162.6	67.4	36	218.0	90.3	96	273.5	113.3
57	52.7	21.8	17	108.1	44.8	77	163.5	67.7	37	219.0	90.7	97	274.4	113.7
58	53.6	22.2	18	109.0	45.2	78	164.5	68.1	38	219.9	91.1	98	275.3	114.0
59	54.5	22.6	19	109.9	45.5	79	165.4	68.5	39	220.8	91.5	99	276.2	114.4
60	55.4	23.0	20	110.9	45.9	80	166.3	68.9	40	221.7	91.8	300	277.2	114.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat,	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

ENE. ESE. WNW WSW [For 6 Points.

TABLE 1.

Difference of Latitude and Departure for 2¼ Points.

NNE. ¼ E. NNW. ¼ W. SSE. ¼ E. SSW. ¼ W.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	0.9	0.4	61	55.1	26.1	121	109.4	51.7	181	163.6	77.4	241	217.9	103.0
2	1.8	0.9	62	56.0	26.5	22	110.3	52.2	82	164.5	77.8	42	218.8	103.5
3	2.7	1.3	63	57.0	26.9	23	111.2	52.6	83	165.4	78.2	43	219.7	103.9
4	3.6	1.7	64	57.9	27.4	24	112.1	53.0	84	166.3	78.7	44	220.6	104.3
5	4.5	2.1	65	58.8	27.8	25	113.0	53.4	85	167.2	79.1	45	221.5	104.8
6	5.4	2.6	66	59.7	28.2	26	113.9	53.9	86	168.1	79.5	46	222.4	105.2
7	6.3	3.0	67	60.6	28.6	27	114.8	54.3	87	169.0	80.0	47	223.3	105.6
8	7.2	3.4	68	61.5	29.1	28	115.7	54.7	88	169.9	80.4	48	224.2	106.0
9	8.1	3.8	69	62.4	29.5	29	116.6	55.2	89	170.9	80.8	49	225.1	106.5
10	9.0	4.3	70	63.3	29.9	30	117.5	55.6	90	171.8	81.2	50	226.0	106.9
11	9.9	4.7	71	64.2	30.4	131	118.4	56.0	191	172.7	81.7	251	226.9	107.3
12	10.8	5.1	72	65.1	30.8	32	119.3	56.4	92	173.6	82.1	52	227.8	107.7
13	11.8	5.6	73	66.0	31.2	33	120.2	56.9	93	174.5	82.5	53	228.7	108.2
14	12.7	6.0	74	66.9	31.6	34	121.1	57.3	94	175.4	82.9	54	229.6	108.6
15	13.6	6.4	75	67.8	32.1	35	122.0	57.7	95	176.3	83.4	55	230.5	109.0
16	14.5	6.8	76	68.7	32.5	36	122.9	58.1	96	177.2	83.8	56	231.4	109.5
17	15.4	7.3	77	69.6	32.9	37	123.8	58.6	97	178.1	84.2	57	232.3	109.9
18	16.3	7.7	78	70.5	33.3	38	124.8	59.0	98	179.0	84.7	58	233.2	110.3
19	17.2	8.1	79	71.4	33.8	39	125.7	59.4	99	179.9	85.1	59	234.1	110.7
20	18.1	8.6	80	72.3	34.2	40	126.6	59.9	200	180.8	85.5	60	235.0	111.2
21	19.0	9.0	81	73.2	34.6	141	127.5	60.3	201	181.7	85.9	261	235.9	111.6
22	19.9	9.4	82	74.1	35.1	42	128.4	60.7	02	182.6	86.4	62	236.8	112.0
23	20.8	9.8	83	75.0	35.5	43	129.3	61.1	03	183.5	86.8	63	237.7	112.4
24	21.7	10.3	84	75.9	35.9	44	130.2	61.6	04	184.4	87.2	64	238.7	112.9
25	22.6	10.7	85	76.8	36.3	45	131.1	62.0	05	185.3	87.6	65	239.6	113.3
26	23.5	11.1	86	77.7	36.8	46	132.0	62.4	06	186.2	88.1	66	240.5	113.7
27	24.4	11.5	87	78.6	37.2	47	132.9	62.9	07	187.1	88.5	67	241.4	114.2
28	25.3	12.0	88	79.6	37.6	48	133.8	63.3	08	188.0	88.9	68	242.3	114.6
29	26.2	12.4	89	80.5	38.1	49	134.7	63.7	09	188.9	89.4	69	243.2	115.0
30	27.1	12.8	90	81.4	38.5	50	135.6	64.1	10	189.8	89.8	70	244.1	115.4
31	28.0	13.3	91	82.3	38.9	151	136.5	64.6	211	190.7	90.2	271	245.0	115.9
32	28.9	13.7	92	83.2	39.3	52	137.4	65.0	12	191.6	90.6	72	245.9	116.3
33	29.8	14.1	93	84.1	39.8	53	138.3	65.4	13	192.5	91.1	73	246.8	116.7
34	30.7	14.5	94	85.0	40.2	54	139.2	65.8	14	193.5	91.5	74	247.7	117.2
35	31.6	15.0	95	85.9	40.6	55	140.1	66.3	15	194.4	91.9	75	248.6	117.6
36	32.5	15.4	96	86.8	41.0	56	141.0	66.7	16	195.3	92.4	76	249.5	118.0
37	33.4	15.8	97	87.7	41.5	57	141.9	67.1	17	196.2	92.8	77	250.4	118.4
38	34.4	16.2	98	88.6	41.9	58	142.8	67.6	18	197.1	93.2	78	251.3	118.9
39	35.3	16.7	99	89.5	42.3	59	143.7	68.0	19	198.0	93.6	79	252.2	119.3
40	36.2	17.1	100	90.4	42.8	60	144.6	68.4	20	198.9	94.1	80	253.1	119.7
41	37.1	17.5	101	91.3	43.2	161	145.5	68.8	221	199.8	94.5	281	254.0	120.1
42	38.0	18.0	02	92.2	43.6	62	146.4	69.3	22	200.7	94.9	82	254.9	120.6
43	38.9	18.4	03	93.1	44.0	63	147.4	69.7	23	201.6	95.3	83	255.8	121.0
44	39.8	18.8	04	94.0	44.5	64	148.3	70.1	24	202.5	95.8	84	256.7	121.4
45	40.7	19.2	05	94.9	44.9	65	149.2	70.5	25	203.4	96.2	85	257.6	121.9
46	41.6	19.7	06	95.8	45.3	66	150.1	71.0	26	204.3	96.6	86	258.5	122.3
47	42.5	20.1	07	96.7	45.7	67	151.0	71.4	27	205.2	97.1	87	259.4	122.7
48	43.4	20.5	08	97.6	46.2	68	151.9	71.8	28	206.1	97.5	88	260.3	123.1
49	44.3	21.0	09	98.5	46.6	69	152.8	72.3	29	207.0	97.9	89	261.3	123.6
50	45.2	21.4	10	99.4	47.0	70	153.7	72.7	30	207.9	98.3	90	262.2	124.0
51	46.1	21.8	111	100.3	47.5	171	154.6	73.1	231	208.8	98.8	291	263.1	124.4
52	47.0	22.2	12	101.2	47.9	72	155.5	73.5	32	209.7	99.2	92	264.0	124.8
53	47.9	22.7	13	102.2	48.3	73	156.4	74.0	33	210.6	99.6	93	264.9	125.3
54	48.8	23.1	14	103.1	48.7	74	157.3	74.4	34	211.5	100.0	94	265.8	125.7
55	49.7	23.5	15	104.0	49.2	75	158.2	74.8	35	212.4	100.5	95	266.7	126.1
56	50.6	23.9	16	104.9	49.6	76	159.1	75.2	36	213.3	100.9	96	267.6	126.6
57	51.5	24.4	17	105.8	50.0	77	160.0	75.7	37	214.2	101.3	97	268.5	127.0
58	52.4	24.8	18	106.7	50.5	78	160.9	76.1	38	215.1	101.8	98	269.4	127.4
59	53.3	25.2	19	107.6	50.9	79	161.8	76.5	39	216.1	102.2	99	270.3	127.8
60	54.2	25.7	20	108.5	51.3	80	162.7	77.0	40	217.0	102.6	300	271.2	128.3
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

NE. by E. ¾ E. SE. by E. ¾ E. NW. by W. ¾ W. SW. by W. ¾ W. [For 5¾ Points.

TABLE 1.

Difference of Latitude and Departure for 2½ Points.

NNE. ½ E. NNW. ½ W. SSE. ½ E. SSW. ½ W.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	0.9	0.5	61	53.8	28.8	121	106.7	57.0	181	159.6	85.3	241	212.5	113.6
2	1.8	0.9	62	54.7	29.2	22	107.6	57.5	82	160.5	85.8	42	213.4	114.1
3	2.6	1.4	63	55.6	29.7	23	108.5	58.0	83	161.4	86.3	43	214.3	114.5
4	3.5	1.9	64	56.4	30.2	24	109.4	58.5	84	162.3	86.7	44	215.2	115.0
5	4.4	2.4	65	57.3	30.6	25	110.2	58.9	85	163.2	87.2	45	216.1	115.5
6	5.3	2.8	66	58.2	31.1	26	111.1	59.4	86	164.0	87.7	46	217.0	116.0
7	6.2	3.3	67	59.1	31.6	27	112.0	59.9	87	164.9	88.2	47	217.8	116.4
8	7.1	3.8	68	60.0	32.1	28	112.9	60.3	88	165.8	88.6	48	218.7	116.9
9	7.9	4.2	69	60.9	32.5	29	113.8	60.8	89	166.7	89.1	49	219.6	117.4
10	8.8	4.7	70	61.7	33.0	30	114.6	61.3	90	167.6	89.6	50	220.5	117.8
11	9.7	5.2	71	62.6	33.5	131	115.5	61.8	191	168.4	90.0	251	221.4	118.3
12	10.6	5.7	72	63.5	33.9	32	116.4	62.2	92	169.3	90.5	52	222.2	118.8
13	11.5	6.1	73	64.4	34.4	33	117.3	62.7	93	170.2	91.0	53	223.1	119.3
14	12.3	6.6	74	65.3	34.9	34	118.2	63.2	94	171.1	91.5	54	224.0	119.7
15	13.2	7.1	75	66.1	35.4	35	119.1	63.6	95	172.0	91.9	55	224.9	120.2
16	14.1	7.5	76	67.0	35.8	36	119.9	64.1	96	172.9	92.4	56	225.8	120.7
17	15.0	8.0	77	67.9	36.3	37	120.8	64.6	97	173.7	92.9	57	226.7	121.1
18	15.9	8.5	78	68.8	36.8	38	121.7	65.1	98	174.6	93.3	58	227.5	121.6
19	16.8	9.0	79	69.7	37.2	39	122.6	65.5	99	175.5	93.8	59	228.4	122.1
20	17.6	9.4	80	70.6	37.7	40	123.5	66.0	200	176.4	94.3	60	229.3	122.6
21	18.5	9.9	81	71.4	38.2	141	124.4	66.5	201	177.3	94.8	261	330.2	123.0
22	19.4	10.4	82	72.3	38.7	42	125.2	66.9	02	178.1	95.2	62	231.1	123.5
23	20.3	10.8	83	73.2	39.1	43	126.1	67.4	03	179.0	95.7	63	231.9	124.0
24	21.2	11.3	84	74.1	39.6	44	127.0	67.9	04	179.9	96.2	64	232.8	124.4
25	22.0	11.8	85	75.0	40.1	45	127.9	68.4	05	180.8	96.6	65	233.7	124.9
26	22.9	12.3	86	75.8	40.5	46	128.8	68.8	06	181.7	97.1	66	234.6	125.4
27	23.8	12.7	87	76.7	41.0	47	129.6	69.3	07	182.6	97.6	67	235.5	125.9
28	24.7	13.2	88	77.6	41.5	48	130.5	69.8	08	183.4	98.1	68	236.4	126.3
29	25.6	13.7	89	78.5	42.0	49	131.4	70.2	09	184.3	98.5	69	237.2	126.8
30	26.5	14.1	90	79.4	42.4	50	132.3	70.7	10	185.2	99.0	70	238.1	127.3
31	27.3	14.6	91	80.3	42.9	151	133.2	71.2	211	186.1	99.5	271	239.0	127.7
32	28.2	15.1	92	81.1	43.4	52	134.1	71.7	12	187.0	99.9	72	239.9	128.2
33	29.1	15.6	93	82.0	43.8	53	134.9	72.1	13	187.8	100.4	73	240.8	128.7
34	30.0	16.0	94	82.9	44.3	54	135.8	72.6	14	188.7	100.9	74	241.6	129.2
35	30.9	16.5	95	83.8	44.8	55	136.7	73.1	15	189.6	101.4	75	242.5	129.6
36	31.7	17.0	96	84.7	45.3	56	137.6	73.5	16	190.5	101.8	76	243.4	130.1
37	32.6	17.4	97	85.5	45.7	57	138.5	74.0	17	191.4	102.3	77	244.3	130.6
38	33.5	17.9	98	86.4	46.2	58	139.3	74.5	18	192.3	102.8	78	245.2	131.0
39	34.4	18.4	99	87.3	46.7	59	140.2	75.0	19	193.1	103.2	79	246.1	131.5
40	35.3	18.9	100	88.2	47.1	60	141.1	75.4	20	194.0	103.7	80	246.9	132.0
41	36.2	19.3	101	89.1	47.6	161	142.0	75.9	221	194.9	104.2	281	247.8	132.5
42	37.0	19.8	02	90.0	48.1	62	142.9	76.4	22	195.8	104.7	82	248.7	132.9
43	37.9	20.3	03	90.8	48.6	63	143.8	76.8	23	196.7	105.1	83	249.6	133.4
44	38.8	20.7	04	91.7	49.0	64	144.6	77.3	24	197.6	105.6	84	250.5	133.9
45	39.7	21.2	05	92.6	49.5	65	145.5	77.8	25	198.4	106.1	85	251.3	134.3
46	40.6	21.7	06	93.5	50.0	66	146.4	78.3	26	199.3	106.5	86	252.2	134.8
47	41.5	22.2	07	94.4	50.4	67	147.3	78.7	27	200.2	107.0	87	253.1	135.3
48	42.3	22.6	08	95.2	50.9	68	148.2	79.2	28	201.1	107.5	88	254.0	135.8
49	43.2	23.1	09	96.1	51.4	69	149.0	79.7	29	202.0	107.9	89	254.9	136.2
50	44.1	23.6	10	97.0	51.9	70	149.9	80.1	30	202.8	108.4	90	255.8	136.7
51	45.0	24.0	111	97.9	52.3	171	150.8	80.6	231	203.7	108.9	291	256.6	137.2
52	45.9	24.5	12	98.8	52.8	72	151.7	81.1	32	204.6	109.4	92	257.5	137.6
53	46.7	25.0	13	99.7	53.3	73	152.6	81.6	33	205.5	109.8	93	258.4	138.1
54	47.6	25.5	14	100.5	53.7	74	153.5	82.0	34	206.4	110.3	94	259.3	138.6
55	48.5	25.9	15	101.4	54.2	75	154.3	82.5	35	207.3	110.8	95	260.2	139.1
56	49.4	26.4	16	102.3	54.7	76	155.2	83.0	36	208.1	111.2	96	261.0	139.5
57	50.3	26.9	17	103.2	55.2	77	156.1	83.4	37	209.0	111.7	97	261.9	140.0
58	51.2	27.3	18	104.1	55.6	78	157.0	83.9	38	209.9	112.2	98	262.8	140.5
59	52.0	27.8	19	104.9	56.1	79	157.9	84.4	39	210.8	112.7	99	263.7	140.9
60	52.9	28.3	20	105.8	56.6	80	158.7	84.9	40	211.7	113.1	300	264.6	141.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

NE. by E. ½ E. SE. by E. ½ E. NW. by W. ½ W. SW. by W. ½ W. [For 5½ Points.

TABLE 1.

Difference of Latitude and Departure for 2¾ Points.

NNE. ¾ E. NNW. ¾ W. SSE. ¾ E. SSW. ¾ W.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	0.9	0.5	61	52.3	31.4	121	103.8	62.2	181	155.2	93.1	241	206.7	123.9
2	1.7	1.0	62	53.2	31.9	22	104.6	62.7	82	156.1	93.6	42	207.6	124.4
3	2.6	1.5	63	54.0	32.4	23	105.5	63.2	83	157.0	94.1	43	208.4	124.9
4	3.4	2.1	64	54.9	32.9	24	106.4	63.7	84	157.8	94.6	44	209.3	125.4
5	4.3	2.6	65	55.8	33.4	25	107.2	64.3	85	158.7	95.1	45	210.1	126.0
6	5.1	3.1	66	56.6	33.9	26	108.1	64.8	86	159.5	95.6	46	211.0	126.5
7	6.0	3.6	67	57.5	34.4	27	108.9	65.3	87	160.4	96.1	47	211.9	127.0
8	6.9	4.1	68	58.3	35.0	28	109.8	65.8	88	161.3	96.7	48	212.7	127.5
9	7.7	4.6	69	59.2	35.5	29	110.6	66.3	89	162.1	97.2	49	213.6	128.0
10	8.6	5.1	70	60.0	36.0	30	111.5	66.8	90	163.0	97.7	50	214.4	128.5
11	9.4	5.7	71	60.9	36.5	131	112.4	67.3	191	163.8	98.2	251	215.3	129.0
12	10.3	6.2	72	61.8	37.0	32	113.2	67.9	92	164.7	98.7	52	216.1	129.6
13	11.2	6.7	73	62.6	37.5	33	114.1	68.4	93	165.5	99.2	53	217.0	130.1
14	12.0	7.2	74	63.5	38.0	34	114.9	68.9	94	166.4	99.7	54	217.9	130.6
15	12.9	7.7	75	64.3	38.6	35	115.8	69.4	95	167.3	100.3	55	218.7	131.1
16	13.7	8.2	76	65.2	39.1	36	116.7	69.9	96	168.1	100.8	56	219.6	131.6
17	14.6	8.7	77	66.0	39.6	37	117.5	70.4	97	169.0	101.3	57	220.4	132.1
18	15.4	9.3	78	66.9	40.1	38	118.4	70.9	98	169.8	101.8	58	221.3	132.6
19	16.3	9.8	79	67.8	40.6	39	119.2	71.5	99	170.7	102.3	59	222.2	133.2
20	17.2	10.3	80	68.6	41.1	40	120.1	72.0	200	171.5	102.8	60	223.0	133.7
21	18.0	10.8	81	69.5	41.6	141	120.9	72.5	201	172.4	103.3	261	223.9	134.2
22	18.9	11.3	82	70.3	42.2	42	121.8	73.0	02	173.3	103.8	62	224.7	134.7
23	19.7	11.8	83	71.2	42.7	43	122.7	73.5	03	174.1	104.4	63	225.6	135.2
24	20.6	12.3	84	72.0	43.2	44	123.5	74.0	04	175.0	104.9	64	226.4	135.7
25	21.4	12.9	85	72.9	43.7	45	124.4	74.5	05	175.8	105.4	65	227.3	136.2
26	22.3	13.4	86	73.8	44.2	46	125.2	75.1	06	176.7	105.9	66	228.2	136.8
27	23.2	13.9	87	74.6	44.7	47	126.1	75.6	07	177.5	106.4	67	229.0	137.3
28	24.0	14.4	88	75.5	45.2	48	126.9	76.1	08	178.4	106.9	68	229.9	137.8
29	24.9	14.9	89	76.3	45.8	49	127.8	76.6	09	179.3	107.4	69	230.7	138.3
30	25.7	15.4	90	77.2	46.3	50	128.7	77.1	10	180.1	108.0	70	231.6	138.8
31	26.6	15.9	91	78.1	46.8	151	129.5	77.6	211	181.0	108.5	271	232.4	139.3
32	27.4	16.5	92	78.9	47.3	52	130.4	78.1	12	181.8	109.0	72	233.3	139.8
33	28.3	17.0	93	79.8	47.8	53	131.2	78.7	13	182.7	109.5	73	234.2	140.4
34	29.2	17.5	94	80.6	48.3	54	132.1	79.2	14	183.6	110.0	74	235.0	140.9
35	30.0	18.0	95	81.5	48.8	55	132.9	79.7	15	184.4	110.5	75	235.9	141.4
36	30.9	18.5	96	82.3	49.4	56	133.8	80.2	16	185.3	111.0	76	236.7	141.9
37	31.7	19.0	97	83.2	49.9	57	134.7	80.7	17	186.1	111.6	77	237.6	142.4
38	32.6	19.5	98	84.1	50.4	58	135.5	81.2	18	187.0	112.1	78	238.4	142.9
39	33.5	20.1	99	84.9	50.9	59	136.4	81.7	19	187.8	112.6	79	239.3	143.4
40	34.3	20.6	100	85.8	51.4	60	137.2	82.3	20	188.7	113.1	80	240.2	143.9
41	35.2	21.1	101	86.6	51.9	161	138.1	82.8	221	189.6	113.6	281	241.0	144.5
42	36.0	21.6	02	87.5	52.4	62	139.0	83.3	22	190.4	114.1	82	241.9	145.0
43	36.9	22.1	03	88.3	53.0	63	139.8	83.8	23	191.3	114.6	83	242.7	145.5
44	37.7	22.6	04	89.2	53.5	64	140.7	84.3	24	192.1	115.2	84	243.6	146.0
45	38.6	23.1	05	90.1	54.0	65	141.5	84.8	25	193.0	115.7	85	244.5	146.5
46	39.5	23.6	06	90.9	54.5	66	142.4	85.3	26	193.8	116.2	86	245.3	147.0
47	40.3	24.2	07	91.8	55.0	67	143.2	85.9	27	194.7	116.7	87	246.2	147.5
48	41.2	24.7	08	92.6	55.5	68	144.1	86.4	28	195.6	117.2	88	247.0	148.1
49	42.0	25.2	09	93.5	56.0	69	145.0	86.9	29	196.4	117.7	89	247.9	148.6
50	42.9	25.7	10	94.4	56.6	70	145.8	87.4	30	197.3	118.2	90	248.7	149.1
51	43.7	26.2	111	95.2	57.1	171	146.7	87.9	231	198.1	118.8	291	249.6	149.6
52	44.6	26.7	12	96.1	57.6	72	147.5	88.4	32	199.0	119.3	92	250.5	150.1
53	45.5	27.2	13	96.9	58.1	73	148.4	88.9	33	199.9	119.8	93	251.3	150.6
54	46.3	27.8	14	97.8	58.6	74	149.2	89.5	34	200.7	120.3	94	252.2	151.1
55	47.2	28.3	15	98.6	59.1	75	150.1	90.0	35	201.6	120.8	95	253.0	151.7
56	48.0	28.8	16	99.5	59.6	76	151.0	90.5	36	202.4	121.3	96	253.9	152.2
57	48.9	29.3	17	100.4	60.2	77	151.8	91.0	37	203.3	121.8	97	254.7	152.7
58	49.7	29.8	18	101.2	60.7	78	152.7	91.5	38	204.1	122.4	98	255.6	153.2
59	50.6	30.3	19	102.1	61.2	79	153.5	92.0	39	205.0	122.9	99	256.5	153.7
60	51.5	30.8	20	102.9	61.7	80	154.4	92.5	40	205.9	123.4	300	257.3	154.2
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

NE. by E. ¼ E. SE. by E. ¼ E. NW. by W. ¼ W. SW. by W. ¼ W. [For 5¼ Points.

TABLE 1.

Difference of Latitude and Departure for 3 Points.

NE. by N. NW. by N. SE. by S. SW. by S.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	0.8	0.6	61	50.7	33.9	121	100.6	67.2	181	150.5	100.6	241	200.4	133.9
2	1.7	1.1	62	51.6	34.4	22	101.4	67.8	82	151.3	101.1	42	201.2	134.4
3	2.5	1.7	63	52.4	35.0	23	102.3	68.3	83	152.2	101.7	43	202.0	135.0
4	3.3	2.2	64	53.2	35.6	24	103.1	68.9	84	153.0	102.2	44	202.9	135.6
5	4.2	2.8	65	54.0	36.1	25	103.9	69.4	85	153.8	102.8	45	203.7	136.1
6	5.0	3.3	66	54.9	36.7	26	104.8	70.0	86	154.7	103.3	46	204.5	136.7
7	5.8	3.9	67	55.7	37.2	27	105.6	70.6	87	155.5	103.9	47	205.4	137.2
8	6.7	4.4	68	56.5	37.8	28	106.4	71.1	88	156.3	104.4	48	206.2	137.8
9	7.5	5.0	69	57.4	38.3	29	107.3	71.7	89	157.1	105.0	49	207.0	138.3
10	8.3	5.6	70	58.2	38.9	30	108.1	72.2	90	158.0	105.6	50	207.9	138.9
11	9.1	6.1	71	59.0	39.4	131	108.9	72.8	191	158.8	106.1	251	208.7	139.4
12	10.0	6.7	72	59.9	40.0	32	109.8	73.3	92	159.6	106.7	52	209.5	140.0
13	10.8	7.2	73	60.7	40.6	33	110.6	73.9	93	160.5	107.2	53	210.4	140.6
14	11.6	7.8	74	61.5	41.1	34	111.4	74.4	94	161.3	107.8	54	211.2	141.1
15	12.5	8.3	75	62.4	41.7	35	112.2	75.0	95	162.1	108.3	55	212.0	141.7
16	13.3	8.9	76	63.2	42.2	36	113.1	75.6	96	163.0	108.9	56	212.9	142.2
17	14.1	9.4	77	64.0	42.8	37	113.9	76.1	97	163.8	109.4	57	213.7	142.8
18	15.0	10.0	78	64.9	43.3	38	114.7	76.7	98	164.6	110.0	58	214.5	143.3
19	15.8	10.6	79	65.7	43.9	39	115.6	77.2	99	165.5	110.6	59	215.4	143.9
20	16.6	11.1	80	66.5	44.4	40	116.4	77.8	200	166.3	111.1	60	216.2	144.4
21	17.5	11.7	81	67.3	45.0	141	117.2	78.3	201	167.1	111.7	261	217.0	145.0
22	18.3	12.2	82	68.2	45.6	42	118.1	78.9	02	168.0	112.2	62	217.8	145.6
23	19.1	12.8	83	69.0	46.1	43	118.9	79.4	03	168.8	112.8	63	218.7	146.1
24	20.0	13.3	84	69.8	46.7	44	119.7	80.0	04	169.6	113.3	64	219.5	146.7
25	20.8	13.9	85	70.7	47.2	45	120.6	80.6	05	170.5	113.9	65	220.3	147.2
26	21.6	14.4	86	71.5	47.8	46	121.4	81.1	06	171.3	114.4	66	221.2	147.8
27	22.4	15.0	87	72.3	48.3	47	122.2	81.7	07	172.1	115.0	67	222.0	148.3
28	23.3	15.6	88	73.2	48.9	48	123.1	82.2	08	172.9	115.6	68	222.8	148.9
29	24.1	16.1	89	74.0	49.4	49	123.9	82.8	09	173.8	116.1	69	223.7	149.4
30	24.9	16.7	90	74.8	50.0	50	124.7	83.3	10	174.6	116.7	70	224.5	150.0
31	25.8	17.2	91	75.7	50.6	151	125.6	83.9	211	175.4	117.2	271	225.3	150.6
32	26.6	17.8	92	76.5	51.1	52	126.4	84.4	12	176.3	117.8	72	226.2	151.1
33	27.4	18.3	93	77.3	51.7	53	127.2	85.0	13	177.1	118.3	73	227.0	151.7
34	28.3	18.9	94	78.2	52.2	54	128.0	85.6	14	177.9	118.9	74	227.8	152.2
35	29.1	19.4	95	79.0	52.8	55	128.9	86.1	15	178.8	119.4	75	228.7	152.8
36	29.9	20.0	96	79.8	53.3	56	129.7	86.7	16	179.6	120.0	76	229.5	153.3
37	30.8	20.6	97	80.7	53.9	57	130.5	87.2	17	180.4	120.6	77	230.3	153.9
38	31.6	21.1	98	81.5	54.4	58	131.4	87.8	18	181.3	121.1	78	231.1	154.4
39	32.4	21.7	99	82.3	55.0	59	132.2	88.3	19	182.1	121.7	79	232.0	155.0
40	33.3	22.2	100	83.1	55.6	60	133.0	88.9	20	182.9	122.2	80	232.8	155.6
41	34.1	22.8	101	84.0	56.1	161	133.9	89.4	221	183.8	122.8	281	233.6	156.1
42	34.9	23.3	02	84.8	56.7	62	134.7	90.0	22	184.6	123.3	82	234.5	156.7
43	35.8	23.9	03	85.6	57.2	63	135.5	90.6	23	185.4	123.9	83	235.3	157.2
44	36.6	24.4	04	86.5	57.8	64	136.4	91.1	24	186.2	124.4	84	236.1	157.8
45	37.4	25.0	05	87.3	58.3	65	137.2	91.7	25	187.1	125.0	85	237.0	158.3
46	38.2	25.6	06	88.1	58.9	66	138.0	92.2	26	187.9	125.6	86	237.8	158.9
47	39.1	26.1	07	89.0	59.4	67	138.9	92.8	27	188.7	126.1	87	238.6	159.4
48	39.9	26.7	08	89.8	60.0	68	139.7	93.3	28	189.6	126.7	88	239.5	160.0
49	40.7	27.2	09	90.6	60.6	69	140.5	93.9	29	190.4	127.2	89	240.3	160.6
50	41.6	27.8	10	91.5	61.1	70	141.3	94.4	30	191.2	127.8	90	241.1	161.1
51	42.4	28.3	111	92.3	61.7	171	142.2	95.0	231	192.1	128.3	291	242.0	161.7
52	43.2	28.9	12	93.1	62.2	72	143.0	95.6	32	192.9	128.9	92	242.8	162.2
53	44.1	29.4	13	94.0	62.8	73	143.8	96.1	33	193.7	129.4	93	243.6	162.8
54	44.9	30.0	14	94.8	63.3	74	144.7	96.7	34	194.6	130.0	94	244.5	163.3
55	45.7	30.6	15	95.6	63.9	75	145.5	97.2	35	195.4	130.6	95	245.3	163.9
56	46.6	31.1	16	96.5	64.4	76	146.3	97.8	36	196.2	131.1	96	246.1	164.4
57	47.4	31.7	17	97.3	65.0	77	147.2	98.3	37	197.1	131.7	97	246.9	165.0
58	48.2	32.2	18	98.1	65.6	78	148.0	98.9	38	197.9	132.2	98	247.8	165.6
59	49.1	32.8	19	98.9	66.1	79	148.8	99.4	39	198.7	132.8	99	248.6	166.1
60	49.9	33.3	20	99.8	66.7	80	149.7	100.0	40	199.6	133.3	300	249.4	166.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

NE. by E. SE. by E. NW. by W. SW. by W. [For 5 Points.

TABLE 1.

Difference of Latitude and Departure for 3¼ Points.

NE. ¾ N. NW. ¾ N. SE. ¾ S. SW. ¾ S.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	0.8	0.6	61	49.0	36.3	121	97.2	72.1	181	145.4	107.8	241	193.6	143.6
2	1.6	1.2	62	49.8	36.9	22	98.0	72.7	82	146.2	108.4	42	194.4	144.2
3	2.4	1.8	63	50.6	37.5	23	98.8	73.3	83	147.0	109.0	43	195.2	144.8
4	3.2	2.4	64	51.4	38.1	24	99.6	73.9	84	147.8	109.6	44	196.0	145.4
5	4.0	3.0	65	52.2	38.7	25	100.4	74.5	85	148.6	110.2	45	196.8	145.9
6	4.8	3.6	66	53.0	39.3	26	101.2	75.1	86	149.4	110.8	46	197.6	146.5
7	5.6	4.2	67	53.8	39.9	27	102.0	75.7	87	150.2	111.4	47	198.4	147.1
8	6.4	4.8	68	54.6	40.5	28	102.8	76.2	88	151.0	112.0	48	199.2	147.7
9	7.2	5.4	69	55.4	41.1	29	103.6	76.8	89	151.8	112.6	49	200.0	148.3
10	8.0	6.0	70	56.2	41.7	30	104.4	77.4	90	152.6	113.2	50	200.8	148.9
11	8.8	6.6	71	57.0	42.3	131	105.2	78.0	191	153.4	113.8	251	201.6	149.5
12	9.6	7.1	72	57.8	42.9	32	106.0	78.6	92	154.2	114.4	52	202.4	150.1
13	10.4	7.7	73	58.6	43.5	33	106.8	79.2	93	155.0	115.0	53	203.2	150.7
14	11.2	8.3	74	59.4	44.1	34	107.6	79.8	94	155.8	115.6	54	204.0	151.3
15	12.0	8.9	75	60.2	44.7	35	108.4	80.4	95	156.6	116.2	55	204.8	151.9
16	12.9	9.5	76	61.0	45.3	36	109.2	81.0	96	157.4	116.8	56	205.6	152.5
17	13.7	10.1	77	61.8	45.9	37	110.0	81.6	97	158.2	117.4	57	206.4	153.1
18	14.5	10.7	78	62.7	46.5	38	110.8	82.2	98	159.0	117.9	58	207.2	153.7
19	15.3	11.3	79	63.5	47.1	39	111.6	82.8	99	159.8	118.5	59	208.0	154.3
20	16.1	11.9	80	64.3	47.7	40	112.4	83.4	200	160.6	119.1	60	208.8	154.9
21	16.9	12.5	81	65.1	48.3	141	113.3	84.0	201	161.4	119.7	261	209.6	155.5
22	17.7	13.1	82	65.9	48.8	42	114.1	84.6	02	162.2	120.3	62	210.4	156.1
23	18.5	13.7	83	66.7	49.4	43	114.9	85.2	03	163.1	120.9	63	211.2	156.7
24	19.3	14.3	84	67.5	50.0	44	115.7	85.8	04	163.9	121.5	64	212.0	157.3
25	20.1	14.9	85	68.3	50.6	45	116.5	86.4	05	164.7	122.1	65	212.8	157.9
26	20.9	15.5	86	69.1	51.2	46	117.3	87.0	06	165.5	122.7	66	213.7	158.5
27	21.7	16.1	87	69.9	51.8	47	118.1	87.6	07	166.3	123.3	67	214.5	159.1
28	22.5	16.7	88	70.7	52.4	48	118.9	88.2	08	167.1	123.9	68	215.3	159.6
29	23.3	17.3	89	71.5	53.0	49	119.7	88.8	09	167.9	124.5	69	216.1	160.2
30	24.1	17.9	90	72.3	53.6	50	120.5	89.4	10	168.7	125.1	70	216.9	160.8
31	24.9	18.5	91	73.1	54.2	151	121.3	90.0	211	169.5	125.7	271	217.7	161.4
32	25.7	19.1	92	73.9	54.8	52	122.1	90.5	12	170.3	126.3	72	218.5	162.0
33	26.5	19.7	93	74.7	55.4	53	122.9	91.1	13	171.1	126.9	73	219.3	162.6
34	27.3	20.3	94	75.5	56.0	54	123.7	91.7	14	171.9	127.5	74	220.1	163.2
35	28.1	20.8	95	76.3	56.6	55	124.5	92.3	15	172.7	128.1	75	220.9	163.8
36	28.9	21.4	96	77.1	57.2	56	125.3	92.9	16	173.5	128.7	76	221.7	164.4
37	29.7	22.0	97	77.9	57.8	57	126.1	93.5	17	174.3	129.3	77	222.5	165.0
38	30.5	22.6	98	78.7	58.4	58	126.9	94.1	18	175.1	129.9	78	223.3	165.6
39	31.3	23.2	99	79.5	59.0	59	127.7	94.7	19	175.9	130.5	79	224.1	166.2
40	32.1	23.8	100	80.3	59.6	60	128.5	95.3	20	176.7	131.1	80	224.9	166.8
41	32.9	24.4	101	81.1	60.2	161	129.3	95.9	221	177.5	131.6	281	225.7	167.4
42	33.7	25.0	02	81.9	60.8	62	130.1	96.5	22	178.3	132.2	82	226.5	168.0
43	34.5	25.6	03	82.7	61.4	63	130.9	97.1	23	179.1	132.8	83	227.3	168.6
44	35.3	26.2	04	83.5	62.0	64	131.7	97.7	24	179.9	133.4	84	228.1	169.2
45	36.1	26.8	05	84.3	62.5	65	132.5	98.3	25	180.7	134.0	85	228.9	169.8
46	36.9	27.4	06	85.1	63.1	66	133.3	98.9	26	181.5	134.6	86	229.7	170.4
47	37.8	28.0	07	85.9	63.7	67	134.1	99.5	27	182.3	135.2	87	230.5	171.0
48	38.6	28.6	08	86.7	64.3	68	134.9	100.1	28	183.1	135.8	88	231.3	171.6
49	39.4	29.2	09	87.5	64.9	69	135.7	100.7	29	183.9	136.4	89	232.1	172.2
50	40.2	29.8	10	88.4	65.5	70	136.5	101.3	30	184.7	137.0	90	232.9	172.8
51	41.0	30.4	111	89.2	66.1	171	137.3	101.9	231	185.5	137.6	291	233.7	173.3
52	41.8	31.0	12	90.0	66.7	72	138.2	102.5	32	186.3	138.2	92	234.5	173.9
53	42.6	31.6	13	90.8	67.3	73	139.0	103.1	33	187.1	138.8	93	235.3	174.5
54	43.4	32.2	14	91.6	67.9	74	139.8	103.7	34	188.0	139.4	94	236.1	175.1
55	44.2	32.8	15	92.4	68.5	75	140.6	104.2	35	188.8	140.0	95	236.9	175.7
56	45.0	33.4	16	93.2	69.1	76	141.4	104.8	36	189.6	140.6	96	237.7	176.3
57	45.8	34.0	17	94.0	69.7	77	142.2	105.4	37	190.4	141.2	97	238.6	176.9
58	46.6	34.6	18	94.8	70.3	78	143.0	106.0	38	191.2	141.8	98	239.4	177.5
59	47.4	35.1	19	95.6	70.9	79	143.8	106.6	39	192.0	142.4	99	240.2	178.1
60	48.2	35.7	20	96.4	71.5	80	144.6	107.2	40	192.8	143.0	300	241.0	178.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

NE. ¾ E. SE. ¾ E. NW. ¾ W. SW. ¾ W. [For 4¾ Points.

TABLE 1.

Difference of Latitude and Departure for 3½ Points.

NE. ½ N. NW. ½ N. SE. ½ S. SW. ½ S.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	0.8	0.6	61	47.2	38.7	121	93.5	76.8	181	139.9	114.8	241	186.3	152.9
2	1.5	1.3	62	47.9	39.3	22	94.3	77.4	82	140.7	115.5	42	187.1	153.5
3	2.3	1.9	63	48.7	40.0	23	95.1	78.0	83	141.5	116.1	43	187.8	154.2
4	3.1	2.5	64	49.5	40.6	24	95.9	78.7	84	142.2	116.7	44	188.6	154.8
5	3.9	3.2	65	50.2	41.2	25	96.6	79.3	85	143.0	117.4	45	189.4	155.4
6	4.6	3.8	66	51.0	41.9	26	97.4	79.9	86	143.8	118.0	46	190.2	156.1
7	5.4	4.4	67	51.8	42.5	27	98.2	80.6	87	144.6	118.6	47	190.9	156.7
8	6.2	5.1	68	52.6	43.1	28	98.9	81.2	88	145.3	119.3	48	191.7	157.3
9	7.0	5.7	69	53.3	43.8	29	99.7	81.8	89	146.1	119.9	49	192.5	158.0
10	7.7	6.3	70	54.1	44.4	30	100.5	82.5	90	146.9	120.5	50	193.3	158.6
11	8.5	7.0	71	54.9	45.0	131	101.3	83.1	191	147.6	121.2	251	194.0	159.2
12	9.3	7.6	72	55.7	45.7	32	102.0	83.7	92	148.4	121.8	52	194.8	159.9
13	10.0	8.2	73	56.4	46.3	33	102.8	84.4	93	149.2	122.4	53	195.6	160.5
14	10.8	8.9	74	57.2	46.9	34	103.6	85.0	94	150.0	123.1	54	196.3	161.1
15	11.6	9.5	75	58.0	47.6	35	104.4	85.6	95	150.7	123.7	55	197.1	161.8
16	12.4	10.2	76	58.7	48.2	36	105.1	86.3	96	151.5	124.3	56	197.9	162.4
17	13.1	10.8	77	59.5	48.8	37	105.9	86.9	97	152.3	125.0	57	198.7	163.0
18	13.9	11.4	78	60.3	49.5	38	106.7	87.5	98	153.1	125.6	58	199.4	163.7
19	14.7	12.1	79	61.1	50.1	39	107.4	88.2	99	153.8	126.2	59	200.2	164.3
20	15.5	12.7	80	61.8	50.8	40	108.2	88.8	200	154.6	126.9	60	201.0	164.9
21	16.2	13.3	81	62.6	51.4	141	109.0	89.4	201	155.4	127.5	261	201.8	165.6
22	17.0	14.0	82	63.4	52.0	42	109.8	90.1	02	156.1	128.1	62	202.5	166.2
23	17.8	14.6	83	64.2	52.7	43	110.5	90.7	03	156.9	128.8	63	203.3	166.8
24	18.6	15.2	84	64.9	53.3	44	111.3	91.4	04	157.7	129.4	64	204.1	167.5
25	19.3	15.9	85	65.7	53.9	45	112.1	92.0	05	158.5	130.1	65	204.8	168.1
26	20.1	16.5	86	66.5	54.6	46	112.9	92.6	06	159.2	130.7	66	205.6	168.7
27	20.9	17.1	87	67.3	55.2	47	113.6	93.3	07	160.0	131.3	67	206.4	169.4
28	21.6	17.8	88	68.0	55.8	48	114.4	93.9	08	160.8	132.0	68	207.2	170.0
29	22.4	18.4	89	68.8	56.5	49	115.2	94.5	09	161.6	132.6	69	207.9	170.7
30	23.2	19.0	90	69.6	57.1	50	116.0	95.2	10	162.3	133.2	70	208.7	171.3
31	24.0	19.7	91	70.3	57.7	151	116.7	95.8	211	163.1	133.9	271	209.5	171.9
32	24.7	20.3	92	71.1	58.4	52	117.5	96.4	12	163.9	134.5	72	210.3	172.6
33	25.5	20.9	93	71.9	59.0	53	118.3	97.1	13	164.7	135.1	73	211.0	173.2
34	26.3	21.6	94	72.7	59.6	54	119.0	97.7	14	165.4	135.8	74	211.8	173.8
35	27.1	22.2	95	73.4	60.3	55	119.8	98.3	15	166.2	136.4	75	212.6	174.5
36	27.8	22.8	96	74.2	60.9	56	120.6	99.0	16	167.0	137.0	76	213.4	175.1
37	28.6	23.5	97	75.0	61.5	57	121.4	99.6	17	167.7	137.7	77	214.1	175.7
38	29.4	24.1	98	75.8	62.2	58	122.1	100.2	18	168.5	138.3	78	214.9	176.4
39	30.1	24.7	99	76.5	62.8	59	122.9	100.9	19	169.3	138.9	79	215.7	177.0
40	30.9	25.4	100	77.3	63.4	60	123.7	101.5	20	170.1	139.6	80	216.4	177.6
41	31.7	26.0	101	78.1	64.1	161	124.5	102.1	221	170.8	140.2	281	217.2	178.3
42	32.5	26.6	02	78.8	64.7	62	125.2	102.8	22	171.6	140.8	82	218.0	178.9
43	33.2	27.3	03	79.6	65.3	63	126.0	103.4	23	172.4	141.5	83	218.8	179.5
44	34.0	27.9	04	80.4	66.0	64	126.8	104.0	24	173.2	142.1	84	219.5	180.2
45	34.8	28.5	05	81.2	66.6	65	127.5	104.7	25	173.9	142.7	85	220.3	180.8
46	35.6	29.2	06	81.9	67.2	66	128.3	105.3	26	174.7	143.4	86	221.1	181.4
47	36.3	29.8	07	82.7	67.9	67	129.1	105.9	27	175.5	144.0	87	221.9	182.1
48	37.1	30.5	08	83.5	68.5	68	129.9	106.6	28	176.2	144.6	88	222.6	182.7
49	37.9	31.1	09	84.3	69.1	69	130.6	107.2	29	177.0	145.3	89	223.4	183.3
50	38.7	31.7	10	85.0	69.8	70	131.4	107.8	30	177.8	145.9	90	224.2	184.0
51	39.4	32.4	111	85.8	70.4	171	132.2	108.5	231	178.6	146.5	291	224.9	184.6
52	40.2	33.0	12	86.6	71.1	72	133.0	109.1	32	179.3	147.2	92	225.7	185.2
53	41.0	33.6	13	87.4	71.7	73	133.7	109.8	33	180.1	147.8	93	226.5	185.9
54	41.7	34.3	14	88.1	72.3	74	134.5	110.4	34	180.9	148.4	94	227.3	186.5
55	42.5	34.9	15	88.9	73.0	75	135.3	111.0	35	181.7	149.1	95	228.0	187.1
56	43.3	35.5	16	89.7	73.6	76	136.0	111.7	36	182.4	149.7	96	228.8	187.8
57	44.1	36.2	17	90.4	74.2	77	136.8	112.3	37	183.2	150.4	97	229.6	188.4
58	44.8	36.8	18	91.2	74.9	78	137.6	112.9	38	184.0	151.0	98	230.4	189.0
59	45.6	37.4	19	92.0	75.5	79	138.4	113.6	39	184.7	151.6	99	231.1	189.7
60	46.4	38.1	20	92.8	76.1	80	139.1	114.2	40	185.5	152.3	300	231.9	190.3
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

NE. ½ E. SE. ½ E. NW. ½ W. SW. ½ W. [For 4½ Points.

TABLE 1.

Difference of Latitude and Departure for 3¾ Points.

NE. ¼ N.			NW. ¼ N.			SE. ¼ S.			SW. ¼ S.					
Dist.	**Lat.**	**Dep.**	**Dist.**	**Lat.**	**Dep.**	**Dist.**	**Lat.**	**Dep.**	**Dist.**	**Lat.**	**Dep.**	**Dist.**	**Lat.**	**Dep.**
1	0.7	0.7	61	45.2	41.0	121	89.7	81.3	181	134.1	121.6	241	178.6	161.8
2	1.5	1.3	62	45.9	41.6	22	90.4	81.9	82	134.9	122.2	42	179.3	162.5
3	2.2	2.0	63	46.7	42.3	23	91.1	82.6	83	135.6	122.9	43	180.1	163.2
4	3.0	2.7	64	47.4	43.0	24	91.9	83.3	84	136.3	123.6	44	180.8	163.9
5	3.7	3.4	65	48.2	43.7	25	92.6	83.9	85	137.1	124.2	45	181.5	164.5
6	4.4	4.0	66	48.9	44.3	26	93.4	84.6	86	137.8	124.9	46	182.3	165.2
7	5.2	4.7	67	49.6	45.0	27	94.1	85.3	87	138.6	125.6	47	183.0	165.9
8	5.9	5.4	68	50.4	45.7	28	94.8	86.0	88	139.3	126.3	48	183.8	166.5
9	6.7	6.0	69	51.1	46.3	29	95.6	86.6	89	140.0	126.9	49	184.5	167.2
10	7.4	6.7	70	51.9	47.0	30	96.3	87.3	90	140.8	127.6	50	185.2	167.9
11	8.2	7.4	71	52.6	47.7	131	97.1	88.0	191	141.5	128.3	251	186.0	168.6
12	8.9	8.1	72	53.3	48.4	32	97.8	88.6	92	142.3	128.9	52	186.7	169.2
13	9.6	8.7	73	54.1	49.0	33	98.5	89.3	93	143.0	129.6	53	187.5	169.9
14	10.4	9.4	74	54.8	49.7	34	99.3	90.0	94	143.7	130.3	54	188.2	170.6
15	11.1	10.1	75	55.6	50.4	35	100.0	90.7	95	144.5	131.0	55	188.9	171.2
16	11.9	10.7	76	56.3	51.0	36	100.8	91.3	96	145.2	131.6	56	189.7	171.9
17	12.6	11.4	77	57.1	51.7	37	101.5	92.0	97	146.0	132.3	57	190.4	172.6
18	13.3	12.1	78	57.8	52.4	38	102.3	92.7	98	146.7	133.0	58	191.2	173.3
19	14.1	12.8	79	58.5	53.1	39	103.0	93.3	99	147.4	133.6	59	191.9	173.9
20	14.8	13.4	80	59.3	53.7	40	103.7	94.0	200	148.2	134.3	60	192.6	174.6
21	15.6	14.1	81	60.0	54.4	141	104.5	94.7	201	148.9	135.0	261	193.4	175.3
22	16.3	14.8	82	60.8	55.1	42	105.2	95.4	02	149.7	135.7	62	194.1	175.9
23	17.0	15.4	83	61.5	55.7	43	106.0	96.0	03	150.4	136.3	63	194.9	176.6
24	17.8	16.1	84	62.2	56.4	44	106.7	96.7	04	151.2	137.0	64	195.6	177.3
25	18.5	16.8	85	63.0	57.1	45	107.4	97.4	05	151.9	137.7	65	196.4	178.0
26	19.3	17.5	86	63.7	57.8	46	108.2	98.0	06	152.6	138.3	66	197.1	178.6
27	20.0	18.1	87	64.5	58.4	47	108.9	98.7	07	153.4	139.0	67	197.8	179.3
28	20.7	18.8	88	65.2	59.1	48	109.7	99.4	08	154.1	139.7	68	198.6	180.0
29	21.5	19.5	89	65.9	59.8	49	110.4	100.1	09	154.9	140.4	69	199.3	180.6
30	22.2	20.1	90	66.7	60.4	50	111.1	100.7	10	155.6	141.0	70	200.1	181.3
31	23.0	20.8	91	67.4	61.1	151	111.9	101.4	211	156.3	141.7	271	200.8	182.0
32	23.7	21.5	92	68.2	61.8	52	112.6	102.1	12	157.1	142.4	72	201.5	182.7
33	24.5	22.2	93	68.9	62.5	53	113.4	102.7	13	157.8	143.0	73	202.3	183.3
34	25.2	22.8	94	69.6	63.1	54	114.1	103.4	14	158.6	143.7	74	203.0	184.0
35	25.9	23.5	95	70.4	63.8	55	114.8	104.1	15	159.3	144.4	75	203.8	184.7
36	26.7	24.2	96	71.1	64.5	56	115.6	104.8	16	160.0	145.1	76	204.5	185.4
37	27.4	24.8	97	71.9	65.1	57	116.3	105.4	17	160.8	145.7	77	205.2	186.0
38	28.2	25.5	98	72.6	65.8	58	117.1	106.1	18	161.5	146.4	78	206.0	186.7
39	28.9	26.2	99	73.4	66.5	59	117.8	106.8	19	162.3	147.1	79	206.7	187.4
40	29.6	26.9	100	74.1	67.2	60	118.6	107.4	20	163.0	147.7	80	207.5	188.0
41	30.4	27.5	101	74.8	67.8	161	119.3	108.1	221	163.8	148.4	281	208.2	188.7
42	31.1	28.2	02	75.6	68.5	62	120.0	108.8	22	164.5	149.1	82	208.9	189.4
43	31.9	28.9	03	76.3	69.2	63	120.8	109.5	23	165.2	149.8	83	209.7	190.1
44	32.6	29.5	04	77.1	69.8	64	121.5	110.1	24	166.0	150.4	84	210.4	190.7
45	33.3	30.2	05	77.8	70.5	65	122.3	110.8	25	166.7	151.1	85	211.2	191.4
46	34.1	30.9	06	78.5	71.2	66	123.0	111.5	26	167.5	151.8	86	211.9	192.1
47	34.8	31.6	07	79.3	71.9	67	123.7	112.2	27	168.2	152.4	87	212.7	192.7
48	35.6	32.2	08	80.0	72.5	68	124.5	112.8	28	168.9	153.1	88	213.4	193.4
49	36.3	32.9	09	80.8	73.2	69	125.2	113.5	29	169.7	153.8	89	214.1	194.1
50	37.0	33.6	10	81.5	73.9	70	126.0	114.2	30	170.4	154.5	90	214.9	194.8
51	37.8	34.2	111	82.2	74.5	171	126.7	114.8	231	171.2	155.1	291	215.6	195.4
52	38.5	34.9	12	83.0	75.2	72	127.4	115.5	32	171.9	155.8	92	216.4	196.1
53	39.3	35.6	13	83.7	75.9	73	128.2	116.2	33	172.6	156.5	93	217.1	196.8
54	40.0	36.3	14	84.5	76.6	74	128.9	116.9	34	173.4	157.1	94	217.8	197.4
55	40.8	36.9	15	85.2	77.2	75	129.7	117.5	35	174.1	157.8	95	218.6	198.1
56	41.5	37.6	16	86.0	77.9	76	130.4	118.2	36	174.9	158.5	96	219.3	198.8
57	42.2	38.3	17	86.7	78.6	77	131.1	118.9	37	175.6	159.2	97	220.1	199.5
58	43.0	39.0	18	87.4	79.2	78	131.9	119.5	38	176.3	159.8	98	220.8	200.1
59	43.7	39.6	19	88.2	79.9	79	132.6	120.2	39	177.1	160.5	99	221.5	200.8
60	44.5	40.3	20	88.9	80.6	80	133.4	120.9	40	177.8	161.2	300	222.3	201.5
Dist.	**Dep.**	**Lat.**	**Dist.**	**Dep.**	**Lat.**	**Dist.**	**Dep.**	**Lat.**	**Dist.**	**Dep.**	**Lat.**	**Dist.**	**Dep.**	**Lat.**
NE. ¼ E.			SE. ¼ E.			NW. ¼ W.			SW. ¼ W.			[For 4¼ Points.		

TABLE 1.

Difference of Latitude and Departure for 4 Points.

NE. NW. SE. SW.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	0.7	0.7	61	43.1	43.1	121	85.6	85.6	181	128.0	128.0	241	170.4	170.4
2	1.4	1.4	62	43.8	43.8	22	86.3	86.3	82	128.7	128.7	42	171.1	171.1
3	2.1	2.1	63	44.5	44.5	23	87.0	87.0	83	129.4	129.4	43	171.8	171.8
4	2.8	2.8	64	45.3	45.3	24	87.7	87.7	84	130.1	130.1	44	172.5	172.5
5	3.5	3.5	65	46.0	46.0	25	88.4	88.4	85	130.8	130.8	45	173.2	173.2
6	4.2	4.2	66	46.7	46.7	26	89.1	89.1	86	131.5	131.5	46	173.9	173.9
7	4.9	4.9	67	47.4	47.4	27	89.8	89.8	87	132.2	132.2	47	174.7	174.7
8	5.7	5.7	68	48.1	48.1	28	90.5	90.5	88	132.9	132.9	48	175.4	175.4
9	6.4	6.4	69	48.8	48.8	29	91.2	91.2	89	133.6	133.6	49	176.1	176.1
10	7.1	7.1	70	49.5	49.5	30	91.9	91.9	90	134.4	134.4	50	176.8	176.8
11	7.8	7.8	71	50.2	50.2	131	92.6	92.6	191	135.1	135.1	251	177.5	177.5
12	8.5	8.5	72	50.0	50.9	32	93.3	93.3	92	135.8	135.8	52	178.2	178.2
13	9.2	9.2	73	51.6	51.6	33	94.0	94.0	93	136.5	136.5	53	178.9	178.9
14	9.9	9.9	74	52.3	52.3	34	94.8	94.8	94	137.2	137.2	54	179.6	179.6
15	10.6	10.6	75	53.0	53.0	35	95.5	95.5	95	137.9	137.9	55	180.3	180.3
16	11.3	11.3	76	53.7	53.7	36	96.2	96.2	96	138.6	138.6	56	181.0	181.0
17	12.0	12.0	77	54.4	54.4	37	96.9	96.9	97	139.3	139.3	57	181.7	181.7
18	12.7	12.7	78	55.2	55.2	38	97.6	97.6	98	140.0	140.0	58	182.4	182.4
19	13.4	13.4	79	55.9	55.9	39	98.3	98.3	99	140.7	140.7	59	183.1	183.1
20	14.1	14.1	80	56.6	56.6	40	99.0	99.0	200	141.4	141.4	60	183.8	183.8
21	14.8	14.8	81	57.3	57.3	141	99.7	99.7	201	142.1	142.1	261	184.6	184.6
22	15.6	15.6	82	58.0	58.0	42	100.4	100.4	02	142.8	142.8	62	185.3	185.3
23	16.3	16.3	83	58.7	58.7	43	101.1	101.1	03	143.5	143.5	63	186.0	186.0
24	17.0	17.0	84	59.4	59.4	44	101.8	101.8	04	144.2	144.2	64	186.7	186.7
25	17.7	17.7	85	60.1	60.1	45	102.5	102.5	05	145.0	145.0	65	187.4	187.4
26	18.4	18.4	86	60.8	60.8	46	103.2	103.2	06	145.7	145.7	66	188.1	188.1
27	19.1	19.1	87	61.5	61.5	47	103.9	103.9	07	146.4	146.4	67	188.8	188.8
28	19.8	19.8	88	62.2	62.2	48	104.7	104.7	08	147.1	147.1	68	189.5	189.5
29	20.5	20.5	89	62.9	62.9	49	105.4	105.4	09	147.8	147.8	69	190.2	190.2
30	21.2	21.2	90	63.6	63.6	50	106.1	106.1	10	148.5	148.5	70	190.9	190.9
31	21.9	21.9	91	64.3	64.3	151	106.8	106.8	211	149.2	149.2	271	191.6	191.6
32	22.6	22.6	92	65.1	65.1	52	107.5	107.5	12	149.9	149.9	72	192.3	192.3
33	23.3	23.3	93	65.8	65.8	53	108.2	108.2	13	150.6	150.6	73	193.0	193.0
34	24.0	24.0	94	66.5	66.5	54	108.9	108.9	14	151.3	151.3	74	193.7	193.7
35	24.7	24.7	95	67.2	67.2	55	109.6	109.6	15	152.0	152.0	75	194.5	194.5
36	25.5	25.5	96	67.9	67.9	56	110.3	110.3	16	152.7	152.7	76	195.2	195.2
37	26.2	26.2	97	68.6	68.6	57	111.0	111.0	17	153.4	153.4	77	195.9	195.9
38	26.9	26.9	98	69.3	69.3	58	111.7	111.7	18	154.1	154.1	78	196.6	196.6
39	27.6	27.6	99	70.0	70.0	59	112.4	112.4	19	154.9	154.9	79	197.3	197.3
40	28.3	28.3	100	70.7	70.7	60	113.1	113.1	20	155.6	155.6	80	198.0	198.0
41	29.0	29.0	101	71.4	71.4	161	113.8	113.8	221	156.3	156.3	281	198.7	198.7
42	29.7	29.7	02	72.1	72.1	62	114.6	114.6	22	157.0	157.0	82	199.4	199.4
43	30.4	30.4	03	72.8	72.8	63	115.3	115.3	23	157.7	157.7	83	200.1	200.1
44	31.1	31.1	04	73.5	73.5	64	116.0	116.0	24	158.4	158.4	84	200.8	200.8
45	31.8	31.8	05	74.2	74.2	65	116.7	116.7	25	159.1	159.1	85	201.5	201.5
46	32.5	32.5	06	75.0	75.0	66	117.4	117.4	26	159.8	159.8	86	202.2	202.2
47	33.2	33.2	07	75.7	75.7	67	118.1	118.1	27	160.5	160.5	87	202.9	202.9
48	33.9	33.9	08	76.4	76.4	68	118.8	118.8	28	161.2	161.2	88	203.6	203.6
49	34.6	34.6	09	77.1	77.1	69	119.5	119.5	29	161.9	161.9	89	204.4	204.4
50	35.4	35.4	10	77.8	77.8	70	120.2	120.2	30	162.6	162.6	90	205.1	205.1
51	36.1	36.1	111	78.5	78.5	171	120.9	120.9	231	163.3	163.3	291	205.8	205.8
52	36.8	36.8	12	79.2	79.2	72	121.6	121.6	32	164.0	164.0	92	206.5	206.5
53	37.5	37.5	13	79.9	79.9	73	122.3	122.3	33	164.8	164.8	93	207.2	207.2
54	38.2	38.2	14	80.6	80.6	74	123.0	123.0	34	165.5	165.5	94	207.9	207.9
55	38.9	38.9	15	81.3	81.3	75	123.7	123.7	35	166.2	166.2	95	208.6	208.6
56	39.6	39.6	16	82.0	82.0	76	124.5	124.5	36	166.9	166.9	96	209.3	209.3
57	40.3	40.3	17	82.7	82.7	77	125.2	125.2	37	167.6	167.6	97	210.0	210.0
58	41.0	41.0	18	83.4	83.4	78	125.9	125.9	38	168.3	168.3	98	210.7	210.7
59	41.7	41.7	19	84.1	84.1	79	126.6	126.6	39	169.0	169.0	99	211.4	211.4
60	42.4	42.4	20	84.9	84.9	80	127.3	127.3	40	169.7	169.7	300	212.1	212.1
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

NE. NW. SE. SW.

TABLE 2.

Difference of Latitude and Departure for 1° (179°, 181°, 359°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	1.0	0.0	61	61.0	1.1	121	121.0	2.1	181	181.0	3.2	241	241.0	4.2
2	2.0	0.0	62	62.0	1.1	22	122.0	2.1	82	182.0	3.2	42	242.0	4.2
3	3.0	0.1	63	63.0	1.1	23	123.0	2.1	83	183.0	3.2	43	243.0	4.2
4	4.0	0.1	64	64.0	1.1	24	124.0	2.2	84	184.0	3.2	44	244.0	4.3
5	5.0	0.1	65	65.0	1.1	25	125.0	2.2	85	185.0	3.2	45	245.0	4.3
6	6.0	0.1	66	66.0	1.2	26	126.0	2.2	86	186.0	3.2	46	246.0	4.3
7	7.0	0.1	67	67.0	1.2	27	127.0	2.2	87	187.0	3.3	47	247.0	4.3
8	8.0	0.1	68	68.0	1.2	28	128.0	2.2	88	188.0	3.3	48	248.0	4.3
9	9.0	0.2	69	69.0	1.2	29	129.0	2.3	89	189.0	3.3	49	249.0	4.3
10	10.0	0.2	70	70.0	1.2	30	130.0	2.3	90	190.0	3.3	50	250.0	4.4
11	11.0	0.2	71	71.0	1.2	131	131.0	2.3	191	191.0	3.3	251	251.0	4.4
12	12.0	0.2	72	72.0	1.3	32	132.0	2.3	92	192.0	3.4	52	252.0	4.4
13	13.0	0.2	73	73.0	1.3	33	133.0	2.3	93	193.0	3.4	53	253.0	4.4
14	14.0	0.2	74	74.0	1.3	34	134.0	2.3	94	194.0	3.4	54	254.0	4.4
15	15.0	0.3	75	75.0	1.3	35	135.0	2.4	95	195.0	3.4	55	255.0	4.5
16	16.0	0.3	76	76.0	1.3	36	136.0	2.4	96	196.0	3.4	56	256.0	4.5
17	17.0	0.3	77	77.0	1.3	37	137.0	2.4	97	197.0	3.4	57	257.0	4.5
18	18.0	0.3	78	78.0	1.4	38	138.0	2.4	98	198.0	3.5	58	258.0	4.5
19	19.0	0.3	79	79.0	1.4	39	139.0	2.4	99	199.0	3.5	59	259.0	4.5
20	20.0	0.3	80	80.0	1.4	40	140.0	2.4	200	200.0	3.5	60	260.0	4.5
21	21.0	0.4	81	81.0	1.4	141	141.0	2.5	201	201.0	3.5	261	261.0	4.6
22	22.0	0.4	82	82.0	1.4	42	142.0	2.5	02	202.0	3.5	62	262.0	4.6
23	23.0	0.4	83	83.0	1.4	43	143.0	2.5	03	203.0	3.5	63	263.0	4.6
24	24.0	0.4	84	84.0	1.5	44	144.0	2.5	04	204.0	3.6	64	264.0	4.6
25	25.0	0.4	85	85.0	1.5	45	145.0	2.5	05	205.0	3.6	65	265.0	4.6
26	26.0	0.5	86	86.0	1.5	46	146.0	2.5	06	206.0	3.6	66	266.0	4.6
27	27.0	0.5	87	87.0	1.5	47	147.0	2.6	07	207.0	3.6	67	267.0	4.7
28	28.0	0.5	88	88.0	1.5	48	148.0	2.6	08	208.0	3.6	68	268.0	4.7
29	29.0	0.5	89	89.0	1.6	49	149.0	2.6	09	209.0	3.6	69	269.0	4.7
30	30.0	0.5	90	90.0	1.6	50	150.0	2.6	10	210.0	3.7	70	270.0	4.7
31	31.0	0.5	91	91.0	1.6	151	151.0	2.6	211	211.0	3.7	271	271.0	4.7
32	32.0	0.6	92	92.0	1.6	52	152.0	2.7	12	212.0	3.7	72	272.0	4.7
33	33.0	0.6	93	93.0	1.6	53	153.0	2.7	13	213.0	3.7	73	273.0	4.8
34	34.0	0.6	94	94.0	1.6	54	154.0	2.7	14	214.0	3.7	74	274.0	4.8
35	35.0	0.6	95	95.0	1.7	55	155.0	2.7	15	215.0	3.8	75	275.0	4.8
36	36.0	0.6	96	96.0	1.7	56	156.0	2.7	16	216.0	3.8	76	276.0	4.8
37	37.0	0.6	97	97.0	1.7	57	157.0	2.7	17	217.0	3.8	77	277.0	4.8
38	38.0	0.7	98	98.0	1.7	58	158.0	2.8	18	218.0	3.8	78	278.0	4.9
39	39.0	0.7	99	99.0	1.7	59	159.0	2.8	19	219.0	3.8	79	279.0	4.9
40	40.0	0.7	100	100.0	1.7	60	160.0	2.8	20	220.0	3.8	80	280.0	4.9
41	41.0	0.7	101	101.0	1.8	161	161.0	2.8	221	221.0	3.9	281	281.0	4.9
42	42.0	0.7	02	102.0	1.8	62	162.0	2.8	22	222.0	3.9	82	282.0	4.9
43	43.0	0.8	03	103.0	1.8	63	163.0	2.8	23	223.0	3.9	83	283.0	4.9
44	44.0	0.8	04	104.0	1.8	64	164.0	2.9	24	224.0	3.9	84	284.0	5.0
45	45.0	0.8	05	105.0	1.8	65	165.0	2.9	25	225.0	3.9	85	285.0	5.0
46	46.0	0.8	06	106.0	1.8	66	166.0	2.9	26	226.0	3.9	86	286.0	5.0
47	47.0	0.8	07	107.0	1.9	67	167.0	2.9	27	227.0	4.0	87	287.0	5.0
48	48.0	0.8	08	108.0	1.9	68	168.0	2.9	28	228.0	4.0	88	288.0	5.0
49	49.0	0.9	09	109.0	1.9	69	169.0	2.9	29	229.0	4.0	89	289.0	5.0
50	50.0	0.9	10	110.0	1.9	70	170.0	3.0	30	230.0	4.0	90	290.0	5.1
51	51.0	0.9	111	111.0	1.9	171	171.0	3.0	231	231.0	4.0	291	291.0	5.1
52	52.0	0.9	12	112.0	2.0	72	172.0	3.0	32	232.0	4.0	92	292.0	5.1
53	53.0	0.9	13	113.0	2.0	73	173.0	3.0	33	233.0	4.1	93	293.0	5.1
54	54.0	0.9	14	114.0	2.0	74	174.0	3.0	34	234.0	4.1	94	294.0	5.1
55	55.0	1.0	15	115.0	2.0	75	175.0	3.1	35	235.0	4.1	95	295.0	5.1
56	56.0	1.0	16	116.0	2.0	76	176.0	3.1	36	236.0	4.1	96	296.0	5.2
57	57.0	1.0	17	117.0	2.0	77	177.0	3.1	37	237.0	4.1	97	297.0	5.2
58	58.0	1.0	18	118.0	2.1	78	178.0	3.1	38	238.0	4.2	98	298.0	5.2
59	59.0	1.0	19	119.0	2.1	79	179.0	3.1	39	239.0	4.2	99	299.0	5.2
60	60.0	1.0	20	120.0	2.1	80	180.0	3.1	40	240.0	4.2	300	300.0	5.2
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

89° (91°, 269°, 271°).

TABLE 2.

Difference of Latitude and Departure for 1° (179°, 181°, 359°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	301.0	5.3	361	360.9	6.3	421	420.9	7.3	481	480.9	8.4	541	540.9	9.5
02	302.0	5.3	62	361.9	6.3	22	421.9	7.4	82	481.9	8.4	42	541.9	9.5
03	303.0	5.3	63	362.9	6.3	23	422.9	7.4	83	482.9	8.5	43	542.9	9.5
04	304.0	5.3	64	363.9	6.4	24	423.9	7.4	84	483.9	8.5	44	543.9	9.5
05	305.0	5.3	65	364.9	6.4	25	424.9	7.4	85	484.9	8.5	45	544.9	9.5
06	306.0	5.3	66	365.9	6.4	26	425.9	7.4	86	485.9	8.5	46	545.9	9.5
07	307.0	5.4	67	366.9	6.4	27	426.9	7.4	87	486.9	8.5	47	546.9	9.6
08	308.0	5.4	68	367.9	6.4	28	427.9	7.5	88	487.9	8.6	48	547.9	9.6
09	309.0	5.4	69	368.9	6.4	29	428.9	7.5	89	488.9	8.6	49	548.9	9.6
10	310.0	5.4	70	369.9	6.5	30	429.9	7.5	90	489.9	8.6	50	549.9	9.6
311	311.0	5.4	371	370.9	6.5	431	430.9	7.5	491	490.9	8.6	551	550.9	9.6
12	312.0	5.4	72	371.9	6.5	32	431.9	7.5	92	491.9	8.6	52	551.9	9.6
13	313.0	5.5	73	372.9	6.5	33	432.9	7.5	93	492.9	8.7	53	552.9	9.7
14	314.0	5.5	74	373.9	6.5	34	433.9	7.6	94	493.9	8.7	54	553.9	9.7
15	315.0	5.5	75	374.9	6.5	35	434.9	7.6	95	494.9	8.7	55	554.9	9.7
16	316.0	5.5	76	375.9	6.6	36	435.9	7.6	96	495.9	8.7	56	555.9	9.7
17	317.0	5.5	77	376.9	6.6	37	436.9	7.6	97	496.9	8.7	57	556.9	9.7
18	318.0	5.5	78	377.9	6.6	38	437.9	7.6	98	497.9	8.7	58	557.9	9.7
19	319.0	5.6	79	378.9	6.6	39	438.9	7.7	99	498.9	8.8	59	558.9	9.8
20	320.0	5.6	80	379.9	6.6	40	439.9	7.7	500	499.9	8.8	60	559.9	9.8
321	321.0	5.6	381	380.9	6.7	441	440.9	7.7	501	500.9	8.8	561	560.9	9.8
22	322.0	5.6	82	381.9	6.7	42	441.9	7.7	02	501.9	8.8	62	561.9	9.8
23	323.0	5.6	83	382.9	6.7	43	442.9	7.7	03	502.9	8.8	63	562.9	9.8
24	324.0	5.6	84	383.9	6.7	44	443.9	7.7	04	503.9	8.8	64	563.9	9.8
25	325.0	5.7	85	384.9	6.7	45	444.9	7.8	05	504.9	8.8	65	564.9	9.9
26	326.0	5.7	86	385.9	6.7	46	445.9	7.8	06	505.9	8.9	66	565.9	9.9
27	327.0	5.7	87	386.9	6.8	47	446.9	7.8	07	506.9	8.9	67	566.9	9.9
28	328.0	5.7	88	387.9	6.8	48	447.9	7.8	08	507.9	8.9	68	567.9	9.9
29	329.0	5.7	89	388.9	6.8	49	448.9	7.8	09	508.9	8.9	69	568.9	9.9
30	330.0	5.8	90	389.9	6.8	50	449.9	7.8	10	509.9	8.9	70	569.9	9.9
331	331.0	5.8	391	390.9	6.8	451	450.9	7.9	511	510.9	9.0	571	570.9	10.0
32	332.0	5.8	92	391.9	6.8	52	451.9	7.9	12	511.9	9.0	72	571.9	10.0
33	333.0	5.8	93	392.9	6.9	53	452.9	7.9	13	512.9	9.0	73	572.9	10.0
34	333.9	5.8	94	393.9	6.9	54	453.9	7.9	14	513.9	9.0	74	573.9	10.0
35	334.9	5.8	95	394.9	6.9	55	454.9	7.9	15	514.9	9.0	75	574.9	10.0
36	335.9	5.9	96	395.9	6.9	56	455.9	8.0	16	515.9	9.0	76	575.9	10.0
37	336.9	5.9	97	396.9	6.9	57	456.9	8.0	17	516.9	9.1	77	576.9	10.1
38	337.9	5.9	98	397.9	6.9	58	457.9	8.0	18	517.9	9.1	78	577.9	10.1
39	338.9	5.9	99	398.9	7.0	59	458.9	8.0	19	518.9	9.1	79	578.9	10.1
40	339.9	5.9	400	399.9	7.0	60	459.9	8.0	20	519.9	9.1	80	579.9	10.1
341	340.9	6.0	401	400.9	7.0	461	460.9	8.0	521	520.9	9.1	581	580.9	10.1
42	341.9	6.0	02	401.9	7.0	62	461.9	8.1	22	521.9	9.1	82	581.9	10.1
43	342.9	6.0	03	402.9	7.0	63	462.9	8.1	23	522.9	9.2	83	582.9	10.2
44	343.9	6.0	04	403.9	7.1	64	463.9	8.1	24	523.9	9.2	84	583.9	10.2
45	344.9	6.0	05	404.9	7.1	65	464.9	8.1	25	524.9	9.2	85	584.9	10.2
46	345.9	6.0	06	405.9	7.1	66	465.9	8.1	26	525.9	9.2	86	585.9	10.2
47	346.9	6.1	07	406.9	7.1	67	466.9	8.1	27	526.9	9.2	87	586.9	10.2
48	347.9	6.1	08	407.9	7.1	68	467.9	8.2	28	527.9	9.2	88	587.9	10.2
49	348.9	6.1	09	408.9	7.1	69	468.9	8.2	29	528.9	9.3	89	588.9	10.3
50	349.9	6.1	10	409.9	7.2	70	469.9	8.2	30	529.9	9.3	90	589.9	10.3
351	350.9	6.1	411	410.9	7.2	471	470.9	8.2	531	530.9	9.3	591	590.9	10.3
52	351.9	6.1	12	411.9	7.2	72	471.9	8.2	32	531.9	9.3	92	591.9	10.3
53	352.9	6.2	13	412.9	7.2	73	472.9	8.2	33	532.9	9.3	93	592.9	10.3
54	353.9	6.2	14	413.9	7.2	74	473.9	8.3	34	533.9	9.3	94	593.9	10.3
55	354.9	6.2	15	414.9	7.2	75	474.9	8.3	35	534.9	9.4	95	594.9	10.4
56	355.9	6.2	16	415.9	7.3	76	475.9	8.3	36	535.9	9.4	96	595.9	10.4
57	356.9	6.2	17	416.9	7.3	77	476.9	8.3	37	536.9	9.4	97	596.9	10.4
58	357.9	6.2	18	417.9	7.3	78	477.9	8.3	38	537.9	9.4	98	597.9	10.4
59	358.9	6.3	19	418.9	7.3	79	478.9	8.4	39	538.9	9.4	99	598.9	10.4
60	359.9	6.3	20	419.9	7.3	80	479.9	8.4	40	539.9	9.4	600	599.9	10.5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

89° (91°, 269°, 271°).

TABLE 2.

Difference of Latitude and Departure for 2° (178°, 182°, 358°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	1.0	0.0	61	61.0	2.1	121	120.9	4.2	181	180.9	6.3	241	240.9	8.4
2	2.0	0.1	62	62.0	2.2	22	121.9	4.3	82	181.9	6.4	42	241.9	8.4
3	3.0	0.1	63	63.0	2.2	23	122.9	4.3	83	182.9	6.4	43	242.9	8.5
4	4.0	0.1	64	64.0	2.2	24	123.9	4.3	84	183.9	6.4	44	243.9	8.5
5	5.0	0.2	65	65.0	2.3	25	124.9	4.4	85	184.9	6.5	45	244.9	8.6
6	6.0	0.2	66	66.0	2.3	26	125.9	4.4	86	185.9	6.5	46	245.9	8.6
7	7.0	0.2	67	67.0	2.3	27	126.9	4.4	87	186.9	6.5	47	246.8	8.6
8	8.0	0.3	68	68.0	2.4	28	127.9	4.5	88	187.9	6.6	48	247.8	8.7
9	9.0	0.3	69	69.0	2.4	29	128.9	4.5	89	188.9	6.6	49	248.8	8.7
10	10.0	0.3	70	70.0	2.4	30	129.9	4.5	90	189.9	6.6	50	249.8	8.7
11	11.0	0.4	71	71.0	2.5	131	130.9	4.6	191	190.9	6.7	251	250.8	8.8
12	12.0	0.4	72	72.0	2.5	32	131.9	4.6	92	191.9	6.7	52	251.8	8.8
13	13.0	0.5	73	73.0	2.5	33	132.9	4.6	93	192.9	6.7	53	252.8	8.8
14	14.0	0.5	74	74.0	2.6	34	133.9	4.7	94	193.9	6.8	54	253.8	8.9
15	15.0	0.5	75	75.0	2.6	35	134.9	4.7	95	194.9	6.8	55	254.8	8.9
16	16.0	0.6	76	76.0	2.7	36	135.9	4.7	96	195.9	6.8	56	255.8	8.9
17	17.0	0.6	77	77.0	2.7	37	136.9	4.8	97	196.9	6.9	57	256.8	9.0
18	18.0	0.6	78	78.0	2.7	38	137.9	4.8	98	197.9	6.9	58	257.8	9.0
19	19.0	0.7	79	79.0	2.8	39	138.9	4.9	99	198.9	6.9	59	258.8	9.0
20	20.0	0.7	80	80.0	2.8	40	139.9	4.9	200	199.9	7.0	60	259.8	9.1
21	21.0	0.7	81	81.0	2.8	141	140.9	4.9	201	200.9	7.0	261	260.8	9.1
22	22.0	0.8	82	82.0	2.9	42	141.9	5.0	02	201.9	7.0	62	261.8	9.1
23	23.0	0.8	83	82.9	2.9	43	142.9	5.0	03	202.9	7.1	63	262.8	9.2
24	24.0	0.8	84	83.9	2.9	44	143.9	5.0	04	203.9	7.1	64	263.8	9.2
25	25.0	0.9	85	84.9	3.0	45	144.9	5.1	05	204.9	7.2	65	264.8	9.2
26	26.0	0.9	86	85.9	3.0	46	145.9	5.1	06	205.9	7.2	66	265.8	9.3
27	27.0	0.9	87	86.9	3.0	47	146.9	5.1	07	206.9	7.2	67	266.8	9.3
28	28.0	1.0	88	87.9	3.1	48	147.9	5.2	08	207.9	7.3	68	267.8	9.4
29	29.0	1.0	89	88.9	3.1	49	148.9	5.2	09	208.9	7.3	69	268.8	9.4
30	30.0	1.0	90	89.9	3.1	50	149.9	5.2	10	209.9	7.3	70	269.8	9.4
31	31.0	1.1	91	90.9	3.2	151	150.9	5.3	211	210.9	7.4	271	270.8	9.5
32	32.0	1.1	92	91.9	3.2	52	151.9	5.3	12	211.9	7.4	72	271.8	9.5
33	33.0	1.2	93	92.9	3.2	53	152.9	5.3	13	212.9	7.4	73	272.8	9.5
34	34.0	1.2	94	93.9	3.3	54	153.9	5.4	14	213.9	7.5	74	273.8	9.6
35	35.0	1.2	95	94.9	3.3	55	154.9	5.4	15	214.9	7.5	75	274.8	9.6
36	36.0	1.3	96	95.9	3.4	56	155.9	5.4	16	215.9	7.5	76	275.8	9.6
37	37.0	1.3	97	96.9	3.4	57	156.9	5.5	17	216.9	7.6	77	276.8	9.7
38	38.0	1.3	98	97.9	3.4	58	157.9	5.5	18	217.9	7.6	78	277.8	9.7
39	39.0	1.4	99	98.9	3.5	59	158.9	5.5	19	218.9	7.6	79	278.8	9.7
40	40.0	1.4	100	99.9	3.5	60	159.9	5.6	20	219.9	7.7	80	279.8	9.8
41	41.0	1.4	101	100.9	3.5	161	160.9	5.6	221	220.9	7.7	281	280.8	9.8
42	42.0	1.5	02	101.9	3.6	62	161.9	5.7	22	221.9	7.7	82	281.8	9.8
43	43.0	1.5	03	102.9	3.6	63	162.9	5.7	23	222.9	7.8	83	282.8	9.9
44	44.0	1.5	04	103.9	3.6	64	163.9	5.7	24	223.9	7.8	84	283.8	9.9
45	45.0	1.6	05	104.9	3.7	65	164.9	5.8	25	224.9	7.9	85	284.8	9.9
46	46.0	1.6	06	105.9	3.7	66	165.9	5.8	26	225.9	7.9	86	285.8	10.0
47	47.0	1.6	07	106.9	3.7	67	166.9	5.8	27	226.9	7.9	87	286.8	10.0
48	48.0	1.7	08	107.9	3.8	68	167.9	5.9	28	227.9	8.0	88	287.8	10.1
49	49.0	1.7	09	108.9	3.8	69	168.9	5.9	29	228.9	8.0	89	288.8	10.1
50	50.0	1.7	10	109.9	3.8	70	169.9	5.9	30	229.9	8.0	90	289.8	10.1
51	51.0	1.8	111	110.9	3.9	171	170.9	6.0	231	230.9	8.1	291	290.8	10.2
52	52.0	1.8	12	111.9	3.9	72	171.9	6.0	32	231.9	8.1	92	291.8	10.2
53	53.0	1.8	13	112.9	3.9	73	172.9	6.0	33	232.9	8.1	93	292.8	10.2
54	54.0	1.9	14	113.9	4.0	74	173.9	6.1	34	233.9	8.2	94	293.8	10.3
55	55.0	1.9	15	114.9	4.0	75	174.9	6.1	35	234.9	8.2	95	294.8	10.3
56	56.0	2.0	16	115.9	4.0	76	175.9	6.1	36	235.9	8.2	96	295.8	10.3
57	57.0	2.0	17	116.9	4.1	77	176.9	6.2	37	236.9	8.3	97	296.8	10.4
58	58.0	2.0	18	117.9	4.1	78	177.9	6.2	38	237.9	8.3	98	297.8	10.4
59	59.0	2.1	19	118.9	4.2	79	178.9	6.2	39	238.9	8.3	99	298.8	10.4
60	60.0	2.1	20	119.9	4.2	80	179.9	6.3	40	239.9	8.4	300	299.8	10.5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

88° (92°, 268°, 272°).

TABLE 2.

Difference of Latitude and Departure for 2° (178°, 182°, 358°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	300.8	10.5	361	360.8	12.6	421	420.8	14.7	481	480.7	16.8	541	540.7	18.9
02	301.8	10.5	62	361.8	12.6	22	421.8	14.7	82	481.7	16.8	42	541.7	18.9
03	302.8	10.6	63	362.8	12.7	23	422.8	14.7	83	482.7	16.8	43	542.7	18.9
04	303.8	10.6	64	363.8	12.7	24	423.8	14.8	84	483.7	16.9	44	543.7	19.0
05	304.8	10.6	65	364.8	12.7	25	424.8	14.8	85	484.7	16.9	45	544.7	19.0
06	305.8	10.7	66	365.8	12.8	26	425.7	14.9	86	485.7	16.9	46	545.7	19.0
07	306.8	10.7	67	366.8	12.8	27	426.7	14.9	87	486.7	17.0	47	546.7	19.1
08	307.8	10.7	68	367.8	12.8	28	427.7	14.9	88	487.7	17.0	48	547.7	19.1
09	308.8	10.8	69	368.8	12.9	29	428.7	15.0	89	488.7	17.0	49	548.7	19.1
10	309.8	10.8	70	369.8	12.9	30	429.7	15.0	90	489.7	17.1	50	549.7	19.2
311	310.8	10.8	371	370.8	12.9	431	430.7	15.0	491	490.7	17.1	551	550.7	19.2
12	311.8	10.9	72	371.8	13.0	32	431.7	15.1	92	491.7	17.1	52	551.7	19.2
13	312.8	10.9	73	372.8	13.0	33	432.7	15.1	93	492.7	17.2	53	552.7	19.3
14	313.8	10.9	74	373.8	13.0	34	433.7	15.1	94	493.7	17.2	54	553.7	19.3
15	314.8	11.0	75	374.8	13.1	35	434.7	15.2	95	494.7	17.2	55	554.7	19.3
16	315.8	11.0	76	375.8	13.1	36	435.7	15.2	96	495.7	17.3	56	555.7	19.4
17	316.8	11.0	77	376.8	13.1	37	436.7	15.2	97	496.7	17.3	57	556.7	19.4
18	317.8	11.1	78	377.8	13.2	38	437.7	15.3	98	497.7	17.3	58	557.7	19.4
19	318.8	11.1	79	378.8	13.2	39	438.7	15.3	99	498.7	17.4	59	558.7	19.5
20	319.8	11.2	80	379.8	13.2	40	439.7	15.3	500	499.7	17.4	60	559.7	19.5
321	320.8	11.2	381	380.8	13.3	441	440.7	15.4	501	500.7	17.5	561	560.7	19.5
22	321.8	11.2	82	381.8	13.3	42	441.7	15.4	02	501.7	17.5	62	561.7	19.6
23	322.8	11.3	83	382.8	13.3	43	442.7	15.4	03	502.7	17.5	63	562.7	19.6
24	323.8	11.3	84	383.8	13.4	44	443.7	15.5	04	503.7	17.6	64	563.7	19.6
25	324.8	11.3	85	384.8	13.4	45	444.7	15.5	05	504.7	17.6	65	564.7	19.7
26	325.8	11.4	86	385.8	13.5	46	445.7	15.6	06	505.7	17.6	66	565.7	19.7
27	326.8	11.4	87	386.8	13.5	47	446.7	15.6	07	506.7	17.7	67	566.7	19.7
28	327.8	11.4	88	387.8	13.5	48	447.7	15.6	08	507.7	17.7	68	567.7	19.8
29	328.8	11.5	89	388.8	13.6	49	448.7	15.7	09	508.7	17.7	69	568.7	19.8
30	329.8	11.5	90	389.8	13.6	50	449.7	15.7	10	509.7	17.8	70	569.7	19.9
331	330.8	11.5	391	390.8	13.6	451	450.7	15.7	511	510.7	17.8	571	570.7	19.9
32	331.8	11.6	92	391.8	13.7	52	451.7	15.8	12	511.7	17.8	72	571.7	19.9
33	332.8	11.6	93	392.8	13.7	53	452.7	15.8	13	512.7	17.9	73	572.7	20.0
34	333.8	11.6	94	393.8	13.7	54	453.7	15.8	14	513.7	17.9	74	573.6	20.0
35	334.8	11.7	95	394.8	13.8	55	454.7	15.9	15	514.7	17.9	75	574.6	20.0
36	335.8	11.7	96	395.8	13.8	56	455.7	15.9	16	515.7	18.0	76	575.6	20.1
37	336.8	11.7	97	396.8	13.8	57	456.7	15.9	17	516.7	18.0	77	576.6	20.1
38	337.8	11.8	98	397.8	13.9	58	457.7	16.0	18	517.7	18.1	78	577.6	20.1
39	338.8	11.8	99	398.8	13.9	59	458.7	16.0	19	518.7	18.1	79	578.6	20.2
40	339.8	11.9	400	399.8	13.9	60	459.7	16.0	20	519.7	18.1	80	579.6	20.2
341	340.8	11.9	401	400.8	14.0	461	460.7	16.1	521	520.7	18.2	581	580.6	20.2
42	341.8	11.9	02	401.8	14.0	62	461.7	16.1	22	521.7	18.2	82	581.6	20.3
43	342.8	12.0	03	402.8	14.0	63	462.7	16.1	23	522.7	18.2	83	582.6	20.3
44	343.8	12.0	04	403.8	14.1	64	463.7	16.2	24	523.7	18.3	84	583.6	20.3
45	344.8	12.0	05	404.8	14.1	65	464.7	16.2	25	524.7	18.3	85	584.6	20.4
46	345.8	12.1	06	405.8	14.2	66	465.7	16.2	26	525.7	18.4	86	585.6	20.4
47	346.8	12.1	07	406.8	14.2	67	466.7	16.3	27	526.7	18.4	87	586.6	20.4
48	347.8	12.1	08	407.8	14.2	68	467.7	16.3	28	527.7	18.4	88	587.6	20.5
49	348.8	12.2	09	408.8	14.3	69	468.7	16.4	29	528.7	18.5	89	588.6	20.5
50	349.8	12.2	10	409.8	14.3	70	469.7	16.4	30	529.7	18.5	90	589.6	20.5
351	350.8	12.2	411	410.8	14.3	471	470.7	16.4	531	530.7	18.5	591	590.6	20.6
52	351.8	12.3	12	411.8	14.4	72	471.7	16.5	32	531.7	18.6	92	591.6	20.6
53	352.8	12.3	13	412.8	14.4	73	472.7	16.5	33	532.7	18.6	93	592.6	20.6
54	353.8	12.3	14	413.8	14.4	74	473.7	16.5	34	533.7	18.6	94	593.6	20.7
55	354.8	12.4	15	414.8	14.5	75	474.7	16.6	35	534.7	18.7	95	594.6	20.7
56	355.8	12.4	16	415.8	14.5	76	475.7	16.6	36	535.7	18.7	96	595.6	20.7
57	356.8	12.4	17	416.8	14.5	77	476.7	16.6	37	536.7	18.7	97	596.6	20.8
58	357.8	12.5	18	417.8	14.6	78	477.7	16.7	38	537.7	18.8	98	597.6	20.8
59	358.8	12.5	19	418.8	14.6	79	478.7	16.7	39	538.7	18.8	99	598.6	20.8
60	359.8	12.5	20	419.8	14.6	80	479.7	16.7	40	539.7	18.8	600	599.6	20.9
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

88° (92°, 268°, 272°).

TABLE 2.

Difference of Latitude and Departure for 3° (177°, 183°, 357°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	1.0	0.1	61	60.9	3.2	121	120.8	6.3	181	180.8	9.5	241	240.7	12.6
2	2.0	0.1	62	61.9	3.2	22	121.8	6.4	82	181.8	9.5	42	241.7	12.7
3	3.0	0.2	63	62.9	3.3	23	122.8	6.4	83	182.7	9.6	43	242.7	12.7
4	4.0	0.2	64	63.9	3.3	24	123.8	6.5	84	183.7	9.6	44	243.7	12.8
5	5.0	0.3	65	64.9	3.4	25	124.8	6.5	85	184.7	9.7	45	244.7	12.8
6	6.0	0.3	66	65.9	3.5	26	125.8	6.6	86	185.7	9.7	46	245.7	12.9
7	7.0	0.4	67	66.9	3.5	27	126.8	6.6	87	186.7	9.8	47	246.7	12.9
8	8.0	0.4	68	67.9	3.6	28	127.8	6.7	88	187.7	9.8	48	247.7	13.0
9	9.0	0.5	69	68.9	3.6	29	128.8	6.8	89	188.7	9.9	49	248.7	13.0
10	10.0	0.5	70	69.9	3.7	30	129.8	6.8	90	189.7	9.9	50	249.7	13.1
11	11.0	0.6	71	70.9	3.7	131	130.8	6.9	191	190.7	10.0	251	250.7	13.1
12	12.0	0.6	72	71.9	3.8	32	131.8	6.9	92	191.7	10.0	52	251.7	13.2
13	13.0	0.7	73	72.9	3.8	33	132.8	7.0	93	192.7	10.1	53	252.7	13.2
14	14.0	0.7	74	73.9	3.9	34	133.8	7.0	94	193.7	10.2	54	253.7	13.3
15	15.0	0.8	75	74.9	3.9	35	134.8	7.1	95	194.7	10.2	55	254.7	13.3
16	16.0	0.8	76	75.9	4.0	36	135.8	7.1	96	195.7	10.3	56	255.6	13.4
17	17.0	0.9	77	76.9	4.0	37	136.8	7.2	97	196.7	10.3	57	256.6	13.5
18	18.0	0.9	78	77.9	4.1	38	137.8	7.2	98	197.7	10.4	58	257.6	13.5
19	19.0	1.0	79	78.9	4.1	39	138.8	7.3	99	198.7	10.4	59	258.6	13.6
20	20.0	1.0	80	79.9	4.2	40	139.8	7.3	200	199.7	10.5	60	259.6	13.6
21	21.0	1.1	81	80.9	4.2	141	140.8	7.4	201	200.7	10.5	261	260.6	13.7
22	22.0	1.2	82	81.9	4.3	42	141.8	7.4	02	201.7	10.6	62	261.6	13.7
23	23.0	1.2	83	82.9	4.3	43	142.8	7.5	03	202.7	10.6	63	262.6	13.8
24	24.0	1.3	84	83.9	4.4	44	143.8	7.5	04	203.7	10.7	64	263.6	13.8
25	25.0	1.3	85	84.9	4.4	45	144.8	7.6	05	204.7	10.7	65	264.6	13.9
26	26.0	1.4	86	85.9	4.5	46	145.8	7.6	06	205.7	10.8	66	265.6	13.9
27	27.0	1.4	87	86.9	4.6	47	146.8	7.7	07	206.7	10.8	67	266.6	14.0
28	28.0	1.5	88	87.9	4.6	48	147.8	7.7	08	207.7	10.9	68	267.6	14.0
29	29.0	1.5	89	88.9	4.7	49	148.8	7.8	09	208.7	10.9	69	268.6	14.1
30	30.0	1.6	90	89.9	4.7	50	149.8	7.9	10	209.7	11.0	70	269.6	14.1
31	31.0	1.6	91	90.9	4.8	151	150.8	7.9	211	210.7	11.0	271	270.6	14.2
32	32.0	1.7	92	91.9	4.8	52	151.8	8.0	12	211.7	11.1	72	271.6	14.2
33	33.0	1.7	93	92.9	4.9	53	152.8	8.0	13	212.7	11.1	73	272.6	14.3
34	34.0	1.8	94	93.9	4.9	54	153.8	8.1	14	213.7	11.2	74	273.6	14.3
35	35.0	1.8	95	94.9	5.0	55	154.8	8.1	15	214.7	11.3	75	274.6	14.4
36	36.0	1.9	96	95.9	5.0	56	155.8	8.2	16	215.7	11.3	76	275.6	14.5
37	36.9	1.9	97	96.9	5.1	57	156.8	8.2	17	216.7	11.4	77	276.6	14.5
38	37.9	2.0	98	97.9	5.1	58	157.8	8.3	18	217.7	11.4	78	277.6	14.6
39	38.9	2.0	99	98.9	5.2	59	158.8	8.3	19	218.7	11.5	79	278.6	14.6
40	39.9	2.1	100	99.9	5.2	60	159.8	8.4	20	219.7	11.5	80	279.6	14.7
41	40.9	2.1	101	100.9	5.3	161	160.8	8.4	221	220.7	11.6	281	280.6	14.7
42	41.9	2.2	02	101.9	5.3	62	161.8	8.5	22	221.7	11.6	82	281.6	14.8
43	42.9	2.3	03	102.9	5.4	63	162.8	8.5	23	222.7	11.7	83	282.6	14.8
44	43.9	2.3	04	103.9	5.4	64	163.8	8.6	24	223.7	11.7	84	283.6	14.9
45	44.9	2.4	05	104.9	5.5	65	164.8	8.6	25	224.7	11.8	85	284.6	14.9
46	45.9	2.4	06	105.9	5.5	66	165.8	8.7	26	225.7	11.8	86	285.6	15.0
47	46.9	2.5	07	106.9	5.6	67	166.8	8.7	27	226.7	11.9	87	286.6	15.0
48	47.9	2.5	08	107.9	5.7	68	167.8	8.8	28	227.7	11.9	88	287.6	15.1
49	48.9	2.6	09	108.9	5.7	69	168.8	8.8	29	228.7	12.0	89	288.6	15.1
50	49.9	2.6	10	109.8	5.8	70	169.8	8.9	30	229.7	12.0	90	289.6	15.2
51	50.9	2.7	111	110.8	5.8	171	170.8	8.9	231	230.7	12.1	291	290.6	15.2
52	51.9	2.7	12	111.8	5.9	72	171.8	9.0	32	231.7	12.1	92	291.6	15.3
53	52.9	2.8	13	112.8	5.9	73	172.8	9.1	33	232.7	12.2	93	292.6	15.3
54	53.9	2.8	14	113.8	6.0	74	173.8	9.1	34	233.7	12.2	94	293.6	15.4
55	54.9	2.9	15	114.8	6.0	75	174.8	9.2	35	234.7	12.3	95	294.6	15.4
56	55.9	2.9	16	115.8	6.1	76	175.8	9.2	36	235.7	12.4	96	295.6	15.5
57	56.9	3.0	17	116.8	6.1	77	176.8	9.3	37	236.7	12.4	97	296.6	15.5
58	57.9	3.0	18	117.8	6.2	78	177.8	9.3	38	237.7	12.5	98	297.6	15.6
59	58.9	3.1	19	118.8	6.2	79	178.8	9.4	39	238.7	12.5	99	298.6	15.6
60	59.9	3.1	20	119.8	6.3	80	179.8	9.4	40	239.7	12.6	300	299.6	15.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

87° (93°, 267°, 273°).

TABLE 2.

Difference of Latitude and Departure for 3° (177°, 183°, 357°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	300.6	15.7	361	360.5	18.9	421	420.4	22.0	481	480.3	25.2	541	540.2	28.3
02	301.6	15.8	62	361.5	19.0	22	421.4	22.1	82	481.3	25.2	42	541.2	28.4
03	302.6	15.9	63	362.5	19.0	23	422.4	22.2	83	482.3	25.3	43	542.2	28.4
04	303.5	15.9	64	363.5	19.1	24	423.4	22.2	84	483.3	25.3	44	543.2	28.5
05	304.5	16.0	65	364.5	19.1	25	424.4	22.3	85	484.3	25.4	45	544.2	28.5
06	305.5	16.0	66	365.5	19.2	26	425.4	22.3	86	485.3	25.4	46	545.2	28.6
07	306.5	16.1	67	366.5	19.2	27	426.4	22.4	87	486.3	25.5	47	546.2	28.6
08	307.5	16.1	68	367.5	19.3	28	427.4	22.4	88	487.3	25.5	48	547.2	28.7
09	308.5	16.2	69	368.5	19.3	29	428.4	22.5	89	488.3	25.6	49	548.2	28.7
10	309.5	16.2	70	369.5	19.4	30	429.4	22.5	90	489.3	25.6	50	549.2	28.8
311	310.5	16.3	371	370.5	19.4	431	430.4	22.6	491	490.3	25.7	551	550.2	28.8
12	311.5	16.3	72	371.5	19.5	32	431.4	22.6	92	491.3	25.7	52	551.2	28.9
13	312.5	16.4	73	372.5	19.5	33	432.4	22.7	93	492.3	25.8	53	552.2	28.9
14	313.5	16.4	74	373.5	19.6	34	433.4	22.7	94	493.3	25.9	54	553.2	29.0
15	314.5	16.5	75	374.5	19.6	35	434.4	22.8	95	494.3	25.9	55	554.2	29.1
16	315.5	16.6	76	375.5	19.7	36	435.4	22.8	96	495.3	26.0	56	555.2	29.1
17	316.5	16.6	77	376.5	19.8	37	436.4	22.9	97	496.3	26.0	57	556.2	29.2
18	317.5	16.7	78	377.4	19.8	38	437.4	22.9	98	497.3	26.1	58	557.2	29.2
19	318.5	16.7	79	378.4	19.9	39	438.4	23.0	99	498.3	26.1	59	558.2	29.3
20	319.5	16.8	80	379.4	19.9	40	439.4	23.0	500	499.3	26.2	60	559.2	29.3
321	320.5	16.8	381	380.4	20.0	441	440.4	23.1	501	500.3	26.2	561	560.2	29.4
22	321.5	16.9	82	381.4	20.0	42	441.4	23.1	02	501.3	26.3	62	561.2	29.4
23	322.5	16.9	83	382.4	20.1	43	442.4	23.2	03	502.3	26.3	63	562.2	29.5
24	323.5	17.0	84	383.4	20.1	44	443.4	23.3	04	503.3	26.4	64	563.2	29.5
25	324.5	17.0	85	384.4	20.2	45	444.4	23.3	05	504.3	26.4	65	564.2	29.6
26	325.5	17.1	86	385.4	20.2	46	445.4	23.4	06	505.3	26.5	66	565.2	29.6
27	326.5	17.1	87	386.4	20.3	47	446.4	23.4	07	506.3	26.5	67	566.2	29.7
28	327.5	17.2	88	387.4	20.3	48	447.4	23.5	08	507.3	26.6	68	567.2	29.7
29	328.5	17.2	89	388.4	20.4	49	448.4	23.5	09	508.3	26.6	69	568.2	29.8
30	329.5	17.3	90	389.4	20.4	50	449.3	23.6	10	509.3	26.7	70	569.2	29.8
331	330.5	17.3	391	390.4	20.5	451	450.3	23.6	511	510.3	26.7	571	570.2	29.9
32	331.5	17.4	92	391.4	20.5	52	451.3	23.7	12	511.3	26.8	72	571.2	29.9
33	332.5	17.5	93	392.4	20.6	53	452.3	23.7	13	512.3	26.8	73	572.2	30.0
34	333.5	17.5	94	393.4	20.6	54	453.3	23.8	14	513.3	26.9	74	573.2	30.0
35	334.5	17.6	95	394.4	20.7	55	454.3	23.8	15	514.3	27.0	75	574.2	30.1
36	335.5	17.6	96	395.4	20.7	56	455.3	23.9	16	515.3	27.0	76	575.2	30.1
37	336.5	17.7	97	396.4	20.8	57	456.3	23.9	17	516.3	27.1	77	576.2	30.2
38	337.5	17.7	98	397.4	20.8	58	457.3	24.0	18	517.3	27.1	78	577.2	30.2
39	338.5	17.8	99	398.4	20.9	59	458.3	24.0	19	518.3	27.2	79	578.2	30.3
40	339.5	17.8	400	399.4	20.9	60	459.3	24.1	20	519.3	27.2	80	579.2	30.3
341	340.5	17.9	401	400.4	21.0	461	460.3	24.1	521	520.3	27.3	581	580.2	30.4
42	341.5	17.9	02	401.4	21.1	62	461.3	24.2	22	521.3	27.3	82	581.2	30.4
43	342.5	18.0	03	402.4	21.1	63	462.3	24.2	23	522.3	27.4	83	582.2	30.5
44	343.5	18.0	04	403.4	21.2	64	463.3	24.3	24	523.3	27.4	84	583.2	30.5
45	344.5	18.1	05	404.4	21.2	65	464.3	24.4	25	524.3	27.5	85	584.2	30.6
46	345.5	18.1	06	405.4	21.3	66	465.3	24.4	26	525.3	27.5	86	585.2	30.6
47	346.5	18.2	07	406.4	21.3	67	466.3	24.5	27	526.3	27.6	87	586.2	30.7
48	347.5	18.2	08	407.4	21.4	68	467.3	24.5	28	527.3	27.6	88	587.2	30.7
49	348.5	18.3	09	408.4	21.4	69	468.3	24.6	29	528.3	27.7	89	588.2	30.8
50	349.5	18.3	10	409.4	21.5	70	469.3	24.6	30	529.3	27.7	90	589.2	30.9
351	350.5	18.4	411	410.4	21.5	471	470.3	24.7	531	530.3	27.8	591	590.2	30.9
52	351.5	18.4	12	411.4	21.6	72	471.3	24.7	32	531.3	27.8	92	591.2	31.0
53	352.5	18.5	13	412.4	21.6	73	472.3	24.8	33	532.3	27.9	93	592.2	31.0
54	353.5	18.5	14	413.4	21.7	74	473.3	24.8	34	533.3	27.9	94	593.2	31.1
55	354.5	18.6	15	414.4	21.7	75	474.3	24.9	35	534.3	28.0	95	594.2	31.1
56	355.5	18.6	16	415.4	21.8	76	475.3	24.9	36	535.3	28.1	96	595.2	31.2
57	356.5	18.7	17	416.4	21.8	77	476.3	25.0	37	536.3	28.1	97	596.2	31.2
58	357.5	18.8	18	417.4	21.9	78	477.3	25.0	38	537.3	28.2	98	597.2	31.3
59	358.5	18.8	19	418.4	21.9	79	478.3	25.1	39	538.3	28.2	99	598.2	31.3
60	359.5	18.9	20	419.4	22.0	80	479.3	25.1	40	539.3	28.3	600	599.2	31.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

87° (93°, 267°, 273°).

TABLE 2.

Difference of Latitude and Departure for 4° (176°, 184°, 356°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	1.0	0.1	61	60.9	4.3	121	120.7	8.4	181	180.6	12.6	241	240.4	16.8
2	2.0	0.1	62	61.8	4.3	22	121.7	8.5	82	181.6	12.7	42	241.4	16.9
3	3.0	0.2	63	62.8	4.4	23	122.7	8.6	83	182.6	12.8	43	242.4	17.0
4	4.0	0.3	64	63.8	4.5	24	123.7	8.6	84	183.6	12.8	44	243.4	17.0
5	5.0	0.3	65	64.8	4.5	25	124.7	8.7	85	184.5	12.9	45	244.4	17.1
6	6.0	0.4	66	65.8	4.6	26	125.7	8.8	86	185.5	13.0	46	245.4	17.2
7	7.0	0.5	67	66.8	4.7	27	126.7	8.9	87	186.5	13.0	47	246.4	17.2
8	8.0	0.6	68	67.8	4.7	28	127.7	8.9	88	187.5	13.1	48	247.4	17.3
9	9.0	0.6	69	68.8	4.8	29	128.7	9.0	89	188.5	13.2	49	248.4	17.4
10	10.0	0.7	70	69.8	4.9	30	129.7	9.1	90	189.5	13.3	50	249.4	17.4
11	11.0	0.8	71	70.8	5.0	131	130.7	9.1	191	190.5	13.3	251	250.4	17.5
12	12.0	0.8	72	71.8	5.0	32	131.7	9.2	92	191.5	13.4	52	251.4	17.6
13	13.0	0.9	73	72.8	5.1	33	132.7	9.3	93	192.5	13.5	53	252.4	17.6
14	14.0	1.0	74	73.8	5.2	34	133.7	9.3	94	193.5	13.5	54	253.4	17.7
15	15.0	1.0	75	74.8	5.2	35	134.7	9.4	95	194.5	13.6	55	254.4	17.8
16	16.0	1.1	76	75.8	5.3	36	135.7	9.5	96	195.5	13.7	56	255.4	17.9
17	17.0	1.2	77	76.8	5.4	37	136.7	9.6	97	196.5	13.7	57	256.4	17.9
18	18.0	1.3	78	77.8	5.4	38	137.7	9.6	98	197.5	13.8	58	257.4	18.0
19	19.0	1.3	79	78.8	5.5	39	138.7	9.7	99	198.5	13.9	59	258.4	18.1
20	20.0	1.4	80	79.8	5.6	40	139.7	9.8	200	199.5	14.0	60	259.4	18.1
21	20.9	1.5	81	80.8	5.7	141	140.7	9.8	201	200.5	14.0	261	260.4	18.2
22	21.9	1.5	82	81.8	5.7	42	141.7	9.9	02	201.5	14.1	62	261.4	18.3
23	22.9	1.6	83	82.8	5.8	43	142.7	10.0	03	202.5	14.2	63	262.4	18.3
24	23.9	1.7	84	83.8	5.9	44	143.6	10.0	04	203.5	14.2	64	263.4	18.4
25	24.9	1.7	85	84.8	5.9	45	144.6	10.1	05	204.5	14.3	65	264.4	18.5
26	25.9	1.8	86	85.8	6.0	46	145.6	10.2	06	205.5	14.4	66	265.4	18.6
27	26.9	1.9	87	86.8	6.1	47	146.6	10.3	07	206.5	14.4	67	266.3	18.6
28	27.9	2.0	88	87.8	6.1	48	147.6	10.3	08	207.5	14.5	68	267.3	18.7
29	28.9	2.0	89	88.8	6.2	49	148.6	10.4	09	208.5	14.6	69	268.3	18.8
30	29.9	2.1	90	89.8	6.3	50	149.6	10.5	10	209.5	14.6	70	269.3	18.8
31	30.9	2.2	91	90.8	6.3	151	150.6	10.5	211	210.5	14.7	271	270.3	18.9
32	31.9	2.2	92	91.8	6.4	52	151.6	10.6	12	211.5	14.8	72	271.3	19.0
33	32.9	2.3	93	92.8	6.5	53	152.6	10.7	13	212.5	14.9	73	272.3	19.0
34	33.9	2.4	94	93.8	6.6	54	153.6	10.7	14	213.5	14.9	74	273.3	19.1
35	34.9	2.4	95	94.8	6.6	55	154.6	10.8	15	214.5	15.0	75	274.3	19.2
36	35.9	2.5	96	95.8	6.7	56	155.6	10.9	16	215.5	15.1	76	275.3	19.3
37	36.9	2.6	97	96.8	6.8	57	156.6	11.0	17	216.5	15.1	77	276.3	19.3
38	37.9	2.7	98	97.8	6.8	58	157.6	11.0	18	217.5	15.2	78	277.3	19.4
39	38.9	2.7	99	98.8	6.9	59	158.6	11.1	19	218.5	15.3	79	278.3	19.5
40	39.9	2.8	100	99.8	7.0	60	159.6	11.2	20	219.5	15.3	80	279.3	19.5
41	40.9	2.9	101	100.8	7.0	161	160.6	11.2	221	220.5	15.4	281	280.3	19.6
42	41.9	2.9	02	101.8	7.1	62	161.6	11.3	22	221.5	15.5	82	281.3	19.7
43	42.9	3.0	03	102.7	7.2	63	162.6	11.4	23	222.5	15.6	83	282.3	19.7
44	43.9	3.1	04	103.7	7.3	64	163.6	11.4	24	223.5	15.6	84	283.3	19.8
45	44.9	3.1	05	104.7	7.3	65	164.6	11.5	25	224.5	15.7	85	284.3	19.9
46	45.9	3.2	06	105.7	7.4	66	165.6	11.6	26	225.4	15.8	86	285.3	20.0
47	46.9	3.3	07	106.7	7.5	67	166.6	11.6	27	226.4	15.8	87	286.3	20.0
48	47.9	3.3	08	107.7	7.5	68	167.6	11.7	28	227.4	15.9	88	287.3	20.1
49	48.9	3.4	09	108.7	7.6	69	168.6	11.8	29	228.4	16.0	89	288.3	20.2
50	49.9	3.5	10	109.7	7.7	70	169.6	11.9	30	229.4	16.0	90	289.3	20.2
51	50.9	3.6	111	110.7	7.7	171	170.6	11.9	231	230.4	16.1	291	290.3	20.3
52	51.9	3.6	12	111.7	7.8	72	171.6	12.0	32	231.4	16.2	92	291.3	20.4
53	52.9	3.7	13	112.7	7.9	73	172.6	12.1	33	232.4	16.3	93	292.3	20.4
54	53.9	3.8	14	113.7	8.0	74	173.6	12.1	34	233.4	16.3	94	293.3	20.5
55	54.9	3.8	15	114.7	8.0	75	174.6	12.2	35	234.4	16.4	95	294.3	20.6
56	55.9	3.9	16	115.7	8.1	76	175.6	12.3	36	235.4	16.5	96	295.3	20.6
57	56.9	4.0	17	116.7	8.2	77	176.6	12.3	37	236.4	16.5	97	296.3	20.7
58	57.9	4.0	18	117.7	8.2	78	177.6	12.4	38	237.4	16.6	98	297.3	20.8
59	58.9	4.1	19	118.7	8.3	79	178.6	12.5	39	238.4	16.7	99	298.3	20.9
60	59.9	4.2	20	119.7	8.4	80	179.6	12.6	40	239.4	16.7	300	299.3	20.9
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

86°; (94°, 266°, 274°).

TABLE 2.

Difference of Latitude and Departure for 4° (176°, 184°, 356°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	300.3	21.0	361	360.1	25.2	421	420.0	29.4	481	479.8	33.5	541	539.7	37.7
02	301.3	21.1	62	361.1	25.2	22	421.0	29.4	82	480.8	33.6	42	540.7	37.8
03	302.2	21.1	63	362.1	25.3	23	422.0	29.5	83	481.8	33.7	43	541.7	37.9
04	303.2	21.2	64	363.1	25.4	24	423.0	29.6	84	482.8	33.7	44	542.7	37.9
05	304.2	21.3	65	364.1	25.5	25	424.0	29.6	85	483.8	33.8	45	543.7	38.0
06	305.2	21.3	66	365.1	25.5	26	424.9	29.7	86	484.8	33.9	46	544.7	38.1
07	306.2	21.4	67	366.1	25.6	27	425.9	29.8	87	485.8	33.9	47	545.7	38.1
08	307.2	21.5	68	367.1	25.7	28	426.9	29.9	88	486.8	34.0	48	546.7	38.2
09	308.2	21.6	69	368.1	25.7	29	427.9	29.9	89	487.8	34.1	49	547.7	38.3
10	309.2	21.6	70	369.1	25.8	30	428.9	30.0	90	488.8	34.2	50	548.7	38.3
311	310.2	21.7	371	370.1	25.9	431	429.9	30.1	491	489.8	34.2	551	549.7	38.4
12	311.2	21.8	72	371.1	25.9	32	430.9	30.1	92	490.8	34.3	52	550.7	38.5
13	312.2	21.8	73	372.1	26.0	33	431.9	30.2	93	491.8	34.4	53	551.7	38.5
14	313.2	21.9	74	373.1	26.1	34	432.9	30.3	94	492.8	34.4	54	552.7	38.6
15	314.2	22.0	75	374.1	26.2	35	433.9	30.3	95	493.8	34.5	55	553.6	38.7
16	315.2	22.1	76	375.1	26.2	36	434.9	30.4	96	494.8	34.6	56	554.6	38.7
17	316.2	22.1	77	376.1	26.3	37	435.9	30.5	97	495.8	34.6	57	555.6	38.8
18	317.2	22.2	78	377.1	26.4	38	436.9	30.6	98	496.8	34.7	58	556.6	38.9
19	318.2	22.3	79	378.1	26.4	39	437.9	30.6	99	497.8	34.8	59	557.6	38.9
20	319.2	22.3	80	379.1	26.5	40	438.9	30.7	500	498.8	34.8	60	558.6	39.0
321	320.2	22.4	381	380.1	26.6	441	439.9	30.8	501	499.8	34.9	561	559.6	39.1
22	321.2	22.5	82	381.1	26.6	42	440.9	30.8	02	500.8	35.0	62	560.6	39.2
23	322.2	22.5	83	382.1	26.7	43	441.9	30.9	03	501.8	35.0	63	561.6	39.2
24	323.2	22.6	84	383.1	26.8	44	442.9	31.0	04	502.8	35.1	64	562.6	39.3
25	324.2	22.7	85	384.0	26.9	45	443.9	31.0	05	503.8	35.2	65	563.6	39.4
26	325.2	22.7	86	385.0	26.9	46	444.9	31.1	06	504.8	35.2	66	564.6	39.4
27	326.2	22.8	87	386.0	27.0	47	445.9	31.2	07	505.8	35.3	67	565.6	39.5
28	327.2	22.9	88	387.0	27.1	48	446.9	31.2	08	506.8	35.4	68	566.6	39.6
29	328.2	23.0	89	388.0	27.1	49	447.9	31.3	09	507.8	35.5	69	567.6	39.7
30	329.2	23.0	90	389.0	27.2	50	448.9	31.4	10	508.8	35.6	70	568.6	39.8
331	330.2	23.1	391	390.0	27.3	451	449.9	31.5	511	509.8	35.6	571	569.6	39.8
32	331.2	23.2	92	391.0	27.3	52	450.9	31.5	12	510.8	35.7	72	570.6	39.9
33	332.2	23.2	93	392.0	27.4	53	451.9	31.6	13	511.8	35.8	73	571.6	40.0
34	333.2	23.3	94	393.0	27.5	54	452.9	31.7	14	512.7	35.8	74	572.6	40.0
35	334.2	23.4	95	394.0	27.6	55	453.9	31.7	15	513.7	35.9	75	573.6	40.1
36	335.2	23.4	96	395.0	27.6	56	454.9	31.8	16	514.7	36.0	76	574.6	40.2
37	336.2	23.5	97	396.0	27.7	57	455.9	31.9	17	515.7	36.0	77	575.6	40.2
38	337.2	23.6	98	397.0	27.8	58	456.9	31.9	18	516.7	36.1	78	576.6	40.3
39	338.2	23.6	99	398.0	27.8	59	457.9	32.0	19	517.7	36.2	79	577.6	40.4
40	339.2	23.7	400	399.0	27.9	60	458.9	32.1	20	518.7	36.2	80	578.6	40.5
341	340.2	23.8	401	400.0	28.0	461	459.9	32.2	521	519.7	36.3	581	579.6	40.5
42	341.2	23.9	02	401.0	28.0	62	460.9	32.2	22	520.7	36.4	82	580.6	40.6
43	342.2	23.9	03	402.0	28.1	63	461.9	32.3	23	521.7	36.4	83	581.6	40.7
44	343.1	24.0	04	403.0	28.2	64	462.9	32.4	24	522.7	36.5	84	582.6	40.7
45	344.1	24.1	05	404.0	28.2	65	463.9	32.4	25	523.7	36.6	85	583.6	40.8
46	345.1	24.1	06	405.0	28.3	66	464.9	32.5	26	524.7	36.7	86	584.6	40.9
47	346.1	24.2	07	406.0	28.4	67	465.8	32.6	27	525.7	36.8	87	585.6	40.9
48	347.1	24.3	08	407.0	28.5	68	466.8	32.6	28	526.7	36.8	88	586.6	41.0
49	348.1	24.3	09	408.0	28.5	69	467.8	32.7	29	527.7	36.9	89	587.6	41.1
50	349.1	24.4	10	409.0	28.6	70	468.8	32.8	30	528.7	37.0	90	588.6	41.2
351	350.1	24.5	411	410.0	28.7	471	469.8	32.9	531	529.7	37.0	591	589.6	41.3
52	351.1	24.6	12	411.0	28.7	72	470.8	32.9	32	530.7	37.1	92	590.6	41.3
53	352.1	24.6	13	412.0	28.8	73	471.8	33.0	33	531.7	37.2	93	591.6	41.4
54	353.1	24.7	14	413.0	28.9	74	472.8	33.1	34	532.7	37.2	94	592.6	41.5
55	354.1	24.8	15	414.0	28.9	75	473.8	33.1	35	533.7	37.3	95	593.6	41.5
56	355.1	24.8	16	415.0	29.0	76	474.8	33.2	36	534.7	37.4	96	594.6	41.6
57	356.1	24.9	17	416.0	29.1	77	475.8	33.3	37	535.7	37.5	97	595.6	41.7
58	357.1	25.0	18	417.0	29.2	78	476.8	33.3	38	536.7	37.5	98	596.6	41.7
59	358.1	25.0	19	418.0	29.2	79	477.8	33.4	39	537.7	37.6	99	597.6	41.8
60	359.1	25.1	20	419.0	29.3	80	478.8	35.5	40	538.7	37.7	600	598.6	41.9
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat

86°; (94°, 266°, 274°).

TABLE 2.

Difference of Latitude and Departure for 5° (175°, 185°, 355°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	1.0	0.1	61	60.8	5.3	121	120.5	10.5	181	180.3	15.8	241	240.1	21.0
2	2.0	0.2	62	61.8	5.4	22	121.5	10.6	82	181.3	15.9	42	241.1	21.1
3	3.0	0.3	63	62.8	5.5	23	122.5	10.7	83	182.3	15.9	43	242.1	21.2
4	4.0	0.3	64	63.8	5.6	24	123.5	10.8	84	183.3	16.0	44	243.1	21.3
5	5.0	0.4	65	64.8	5.7	25	124.5	10.9	85	184.3	16.1	45	244.1	21.4
6	6.0	0.5	66	65.7	5.8	26	125.5	11.0	86	185.3	16.2	46	245.1	21.4
7	7.0	0.6	67	66.7	5.8	27	126.5	11.1	87	186.3	16.3	47	246.1	21.5
8	8.0	0.7	68	67.7	5.9	28	127.5	11.2	88	187.3	16.4	48	247.1	21.6
9	9.0	0.8	69	68.7	6.0	29	128.5	11.2	89	188.3	16.5	49	248.1	21.7
10	10.0	0.9	70	69.7	6.1	30	129.5	11.3	90	189.3	16.6	50	249.0	21.8
11	11.0	1.0	71	70.7	6.2	131	130.5	11.4	191	190.3	16.6	251	250.0	21.9
12	12.0	1.0	72	71.7	6.3	32	131.5	11.5	92	191.3	16.7	52	251.0	22.0
13	13.0	1.1	73	72.7	6.4	33	132.5	11.6	93	192.3	16.8	53	252.0	22.1
14	13.9	1.2	74	73.7	6.4	34	133.5	11.7	94	193.3	16.9	54	253.0	22.1
15	14.9	1.3	75	74.7	6.5	35	134.5	11.8	95	194.3	17.0	55	254.0	22.2
16	15.9	1.4	76	75.7	6.6	36	135.5	11.9	96	195.3	17.1	56	255.0	22.3
17	16.9	1.5	77	76.7	6.7	37	136.5	11.9	97	196.3	17.2	57	256.0	22.4
18	17.9	1.6	78	77.7	6.8	38	137.5	12.0	98	197.2	17.3	58	257.0	22.5
19	18.9	1.7	79	78.7	6.9	39	138.5	12.1	99	198.2	17.3	59	258.0	22.6
20	19.9	1.7	80	79.7	7.0	40	139.5	12.2	200	199.2	17.4	60	259.0	22.7
21	20.9	1.8	81	80.7	7.1	141	140.5	12.3	201	200.2	17.5	261	260.0	22.7
22	21.9	1.9	82	81.7	7.1	42	141.5	12.4	02	201.2	17.6	62	261.0	22.8
23	22.9	2.0	83	82.7	7.2	43	142.5	12.5	03	202.2	17.7	63	262.0	22.9
24	23.9	2.1	84	83.7	7.3	44	143.5	12.6	04	203.2	17.8	64	263.0	23.0
25	24.9	2.2	85	84.7	7.4	45	144.4	12.6	05	204.2	17.9	65	264.0	23.1
26	25.9	2.3	86	85.7	7.5	46	145.4	12.7	06	205.2	18.0	66	265.0	23.2
27	26.9	2.4	87	86.7	7.6	47	146.4	12.8	07	206.2	18.0	67	266.0	23.3
28	27.9	2.4	88	87.7	7.7	48	147.4	12.9	08	207.2	18.1	68	267.0	23.4
29	28.9	2.5	89	88.7	7.8	49	148.4	13.0	09	208.2	18.2	69	268.0	23.4
30	29.9	2.6	90	89.7	7.8	50	149.4	13.1	10	209.2	18.3	70	269.0	23.5
31	30.9	2.7	91	90.7	7.9	151	150.4	13.2	211	210.2	18.4	271	270.0	23.6
32	31.9	2.8	92	91.6	8.0	52	151.4	13.2	12	211.2	18.5	72	271.0	23.7
33	32.9	2.9	93	92.6	8.1	53	152.4	13.3	13	212.2	18.6	73	272.0	23.8
34	33.9	3.0	94	93.6	8.2	54	153.4	13.4	14	213.2	18.7	74	273.0	23.9
35	34.9	3.1	95	94.6	8.3	55	154.4	13.5	15	214.2	18.7	75	274.0	24.0
36	35.9	3.1	96	95.6	8.4	56	155.4	13.6	16	215.2	18.8	76	274.9	24.1
37	36.9	3.2	97	96.6	8.5	57	156.4	13.7	17	216.2	18.9	77	275.9	24.1
38	37.9	3.3	98	97.6	8.5	58	157.4	13.8	18	217.2	19.0	78	276.9	24.2
39	38.9	3.4	99	98.6	8.6	59	158.4	13.9	19	218.2	19.1	79	277.9	24.3
40	39.8	3.5	100	99.6	8.7	60	159.4	13.9	20	219.2	19.2	80	278.9	24.4
41	40.8	3.6	101	100.6	8.8	161	160.4	14.0	221	220.2	19.3	281	279.9	24.5
42	41.8	3.7	02	101.6	8.9	62	161.4	14.1	22	221.2	19.3	82	280.9	24.6
43	42.8	3.7	03	102.6	9.0	63	162.4	14.2	23	222.2	19.4	83	281.9	24.7
44	43.8	3.8	04	103.6	9.1	64	163.4	14.3	24	223.1	19.5	84	282.9	24.8
45	44.8	3.9	05	104.6	9.2	65	164.4	14.4	25	224.1	19.6	85	283.9	24.8
46	45.8	4.0	06	105.6	9.2	66	165.4	14.5	26	225.1	19.7	86	284.9	24.9
47	46.8	4.1	07	106.6	9.3	67	166.4	14.6	27	226.1	19.8	87	285.9	25.0
48	47.8	4.2	08	107.6	9.4	68	167.4	14.6	28	227.1	19.9	88	286.9	25.1
49	48.8	4.3	09	108.6	9.5	69	168.4	14.7	29	228.1	20.0	89	287.9	25.2
50	49.8	4.4	10	109.6	9.6	70	169.4	14.8	30	229.1	20.0	90	288.9	25.3
51	50.8	4.4	111	110.6	9.7	171	170.3	14.9	231	230.1	20.1	291	289.9	25.4
52	51.8	4.5	12	111.6	9.8	72	171.3	15.0	32	231.1	20.2	92	290.9	25.4
53	52.8	4.6	13	112.6	9.8	73	172.3	15.1	33	232.1	20.3	93	291.9	25.5
54	53.8	4.7	14	113.6	9.9	74	173.3	15.2	34	233.1	20.4	94	292.9	25.6
55	54.8	4.8	15	114.6	10.0	75	174.3	15.3	35	234.1	20.5	95	293.9	25.7
56	55.8	4.9	16	115.6	10.1	76	175.3	15.3	36	235.1	20.6	96	294.9	25.8
57	56.8	5.0	17	116.6	10.2	77	176.3	15.4	37	236.1	20.7	97	295.9	25.9
58	57.8	5.1	18	117.6	10.3	78	177.3	15.5	38	237.1	20.7	98	296.9	26.0
59	58.8	5.1	19	118.5	10.4	79	178.3	15.6	39	238.1	20.8	99	297.9	26.1
60	59.8	5.2	20	119.5	10.5	80	179.3	15.7	40	239.1	20.9	300	298.9	26.1
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

85° (95°, 265°, 275°).

TABLE 2.

Difference of Latitude and Departure for 5° (175°, 185°, 355°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	299.9	26.2	361	359.6	31.5	421	419.4	36.7	481	479.2	41.9	541	538.9	47.2
02	300.8	26.3	62	360.6	31.6	22	420.4	36.8	82	480.2	42.0	42	539.9	47.3
03	301.8	26.4	63	361.6	31.6	23	421.4	36.9	83	481.2	42.1	43	540.9	47.4
04	302.8	26.5	64	362.6	31.7	24	422.4	37.0	84	482.2	42.2	44	541.9	47.5
05	303.8	26.6	65	363.6	31.8	25	423.4	37.1	85	483.2	42.3	45	542.9	47.6
06	304.8	26.7	66	364.6	31.9	26	424.4	37.1	86	484.1	42.4	46	543.9	47.7
07	305.8	26.8	67	365.6	32.0	27	425.4	37.2	87	485.1	42.4	47	544.9	47.7
08	306.8	26.9	68	366.6	32.1	28	426.4	37.3	88	486.1	42.5	48	545.9	47.8
09	307.8	26.9	69	367.6	32.2	29	427.4	37.4	89	487.1	42.6	49	546.9	47.9
10	308.8	27.0	70	368.6	32.3	30	428.4	37.5	90	488.1	42.7	50	547.9	48.0
311	309.8	27.1	371	369.6	32.3	431	429.4	37.6	491	489.1	42.8	551	548.9	48.1
12	310.8	27.2	72	370.6	32.4	32	430.4	37.7	92	490.1	42.9	52	549.9	48.2
13	311.8	27.3	73	371.6	32.5	33	431.3	37.7	93	491.1	43.0	53	550.9	48.3
14	312.8	27.4	74	372.6	32.6	34	432.3	37.8	94	492.1	43.1	54	551.9	48.4
15	313.8	27.5	75	373.6	32.7	35	433.3	37.9	95	493.1	43.1	55	552.9	48.4
16	314.8	27.5	76	374.6	32.8	36	434.3	38.0	96	494.1	43.2	56	553.9	48.5
17	315.8	27.6	77	375.6	32.9	37	435.3	38.1	97	495.1	43.3	57	554.9	48.6
18	316.8	27.7	78	376.6	33.0	38	436.3	38.2	98	496.1	43.4	58	555.9	48.7
19	317.8	27.8	79	377.6	33.0	39	437.3	38.3	99	497.1	43.5	59	556.9	48.8
20	318.8	27.9	80	378.6	33.1	40	438.3	38.4	500	498.1	43.6	60	557.9	48.8
321	319.8	28.0	381	379.5	33.2	441	439.3	38.4	501	499.1	43.7	561	558.8	48.9
22	320.8	28.1	82	380.5	33.3	42	440.3	38.5	02	500.1	43.8	62	559.8	49.0
23	321.8	28.2	83	381.5	33.4	43	441.3	38.6	03	501.1	43.8	63	560.8	49.1
24	322.8	28.2	84	382.5	33.5	44	442.3	38.7	04	502.1	43.9	64	561.8	49.2
25	323.8	28.3	85	383.5	33.6	45	443.3	38.8	05	503.1	44.0	65	562.8	49.3
26	324.8	28.4	86	384.5	33.7	46	444.3	38.9	06	504.1	44.1	66	563.8	49.4
27	325.8	28.5	87	385.5	33.7	47	445.3	39.0	07	505.1	44.2	67	564.8	49.5
28	326.7	28.6	88	386.5	33.8	48	446.3	39.1	08	506.1	44.3	68	565.8	49.6
29	327.7	28.7	89	387.5	33.9	49	447.3	39.1	09	507.1	44.4	69	566.8	49.7
30	328.7	28.8	90	388.5	34.0	50	448.3	39.2	10	508.1	44.5	70	567.8	49.7
331	329.7	28.9	391	389.5	34.1	451	449.3	39.3	511	509.0	44.5	571	568.8	49.8
32	330.7	28.9	92	390.5	34.2	52	450.3	39.4	12	510.0	44.6	72	569.8	49.9
33	331.7	29.0	93	391.5	34.3	53	451.3	39.5	13	511.0	44.7	73	570.8	50.0
34	332.7	29.1	94	392.5	34.3	54	452.3	39.6	14	512.0	44.8	74	571.8	50.1
35	333.7	29.2	95	393.5	34.4	55	453.3	39.7	15	513.0	44.9	75	572.8	50.2
36	334.7	29.3	96	394.5	34.5	56	454.3	39.8	16	514.0	45.0	76	573.8	50.3
37	335.7	29.4	97	395.5	34.6	57	455.3	39.8	17	515.0	45.1	77	574.8	50.4
38	336.7	29.5	98	396.5	34.7	58	456.3	39.9	18	516.0	45.2	78	575.8	50.4
39	337.7	29.6	99	397.5	34.8	59	457.3	40.0	19	517.0	45.2	79	576.8	50.5
40	338.7	29.6	400	398.5	34.9	60	458.2	40.1	20	518.0	45.3	80	577.8	50.6
341	339.7	29.7	401	399.5	35.0	461	459.2	40.2	521	519.0	45.4	581	578.8	50.7
42	340.7	29.8	02	400.5	35.0	62	460.2	40.3	22	520.0	45.5	82	579.8	50.8
43	341.7	29.9	03	401.5	35.1	63	461.2	40.4	23	521.0	45.6	83	580.8	50.9
44	342.7	30.0	04	402.5	35.2	64	462.2	40.4	24	522.0	45.7	84	581.8	50.9
45	343.7	30.1	05	403.5	35.3	65	463.2	40.5	25	523.0	45.8	85	582.8	51.0
46	344.7	30.2	06	404.5	35.4	66	464.2	40.6	26	524.0	45.9	86	583.8	51.1
47	345.7	30.3	07	405.4	35.5	67	465.2	40.7	27	525.0	45.9	87	584.8	51.2
48	346.7	30.3	08	406.4	35.6	68	466.2	40.8	28	526.0	46.0	88	585.8	51.3
49	347.7	30.4	09	407.4	35.7	69	467.2	40.9	29	527.0	46.1	89	586.8	51.4
50	348.7	30.5	10	408.4	35.7	70	468.2	41.0	30	528.0	46.2	90	587.8	51.5
351	349.7	30.6	411	409.4	35.8	471	469.2	41.1	531	529.0	46.3	591	588.7	51.6
52	350.7	30.7	12	410.4	35.9	72	470.2	41.1	32	530.0	46.4	92	589.7	51.6
53	351.7	30.8	13	411.4	36.0	73	471.2	41.2	33	531.0	46.5	93	590.7	51.7
54	352.6	30.9	14	412.4	36.1	74	472.2	41.3	34	532.0	46.6	94	591.7	51.8
55	353.6	30.9	15	413.4	36.2	75	473.2	41.4	35	533.0	46.6	95	592.7	51.9
56	354.6	31.0	16	414.4	36.3	76	474.2	41.5	36	533.9	46.7	96	593.7	52.0
57	355.6	31.1	17	415.4	36.4	77	475.2	41.6	37	534.9	46.8	97	594.7	52.1
58	356.6	31.2	18	416.4	36.4	78	476.2	41.7	38	535.9	46.9	98	595.7	52.2
59	357.6	31.3	19	417.4	36.5	79	477.2	41.8	39	536.9	47.0	99	596.7	52.3
60	358.6	31.4	20	418.4	36.6	80	478.2	41.8	40	537.9	47.1	600	597.7	52.3
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

85° (95°, 265°, 275°).

TABLE 2.

Difference of Latitude and Departure for 6° (174°, 186°, 354°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	1.0	0.1	61	60.7	6.4	121	120.3	12.6	181	180.0	18.9	241	239.7	25.2
2	2.0	0.2	62	61.7	6.5	22	121.3	12.8	82	181.0	19.0	42	240.7	25.3
3	3.0	0.3	63	62.7	6.6	23	122.3	12.9	83	182.0	19.1	43	241.7	25.4
4	4.0	0.4	64	63.6	6.7	24	123.3	13.0	84	183.0	19.2	44	242.7	25.5
5	5.0	0.5	65	64.6	6.8	25	124.3	13.1	85	184.0	19.3	45	243.7	25.6
6	6.0	0.6	66	65.6	6.9	26	125.3	13.2	86	185.0	19.4	46	244.7	25.7
7	7.0	0.7	67	66.6	7.0	27	126.3	13.3	87	186.0	19.5	47	245.6	25.8
8	8.0	0.8	68	67.6	7.1	28	127.3	13.4	88	187.0	19.7	48	246.6	25.9
9	9.0	0.9	69	68.6	7.2	29	128.3	13.5	89	188.0	19.8	49	247.6	26.0
10	9.9	1.0	70	69.6	7.3	30	129.3	13.6	90	189.0	19.9	50	248.6	26.1
11	10.9	1.1	71	70.6	7.4	131	130.3	13.7	191	190.0	20.0	251	249.6	26.2
12	11.9	1.3	72	71.6	7.5	32	131.3	13.8	92	190.9	20.1	52	250.6	26.3
13	12.9	1.4	73	72.6	7.6	33	132.3	13.9	93	191.9	20.2	53	251.6	26.4
14	13.9	1.5	74	73.6	7.7	34	133.3	14.0	94	192.9	20.3	54	252.6	26.6
15	14.9	1.6	75	74.6	7.8	35	134.3	14.1	95	193.9	20.4	55	253.6	26.7
16	15.9	1.7	76	75.6	7.9	36	135.3	14.2	96	194.9	20.5	56	254.6	26.8
17	16.9	1.8	77	76.6	8.0	37	136.2	14.3	97	195.9	20.6	57	255.6	26.9
18	17.9	1.9	78	77.6	8.2	38	137.2	14.4	98	196.9	20.7	58	256.6	27.0
19	18.9	2.0	79	78.6	8.3	39	138.2	14.5	99	197.9	20.8	59	257.6	27.1
20	19.9	2.1	80	79.6	8.4	40	139.2	14.6	200	198.9	20.9	60	258.6	27.2
21	20.9	2.2	81	80.6	8.5	141	140.2	14.7	201	199.9	21.0	261	259.6	27.3
22	21.9	2.3	82	81.6	8.6	42	141.2	14.8	02	200.9	21.1	62	260.6	27.4
23	22.9	2.4	83	82.5	8.7	43	142.2	14.9	03	201.9	21.2	63	261.6	27.5
24	23.9	2.5	84	83.5	8.8	44	143.2	15.1	04	202.9	21.3	64	262.6	27.6
25	24.9	2.6	85	84.5	8.9	45	144.2	15.2	05	203.9	21.4	65	263.5	27.7
26	25.9	2.7	86	85.5	9.0	46	145.2	15.3	06	204.9	21.5	66	264.5	27.8
27	26.9	2.8	87	86.5	9.1	47	146.2	15.4	07	205.9	21.6	67	265.5	27.9
28	27.8	2.9	88	87.5	9.2	48	147.2	15.5	08	206.9	21.7	68	266.5	28.0
29	28.8	3.0	89	88.5	9.3	49	148.2	15.6	09	207.9	21.8	69	267.5	28.1
30	29.8	3.1	90	89.5	9.4	50	149.2	15.7	10	208.8	22.0	70	268.5	28.2
31	30.8	3.2	91	90.5	9.5	151	150.2	15.8	211	209.8	22.1	271	269.5	28.3
32	31.8	3.3	92	91.5	9.6	52	151.2	15.9	12	210.8	22.2	72	270.5	28.4
33	32.8	3.4	93	92.5	9.7	53	152.2	16.0	13	211.8	22.3	73	271.5	28.5
34	33.8	3.6	94	93.5	9.8	54	153.2	16.1	14	212.8	22.4	74	272.5	28.6
35	34.8	3.7	95	94.5	9.9	55	154.2	16.2	15	213.8	22.5	75	273.5	28.7
36	35.8	3.8	96	95.5	10.0	56	155.1	16.3	16	214.8	22.6	76	274.5	28.8
37	36.8	3.9	97	96.5	10.1	57	156.1	16.4	17	215.8	22.7	77	275.5	29.0
38	37.8	4.0	98	97.5	10.2	58	157.1	16.5	18	216.8	22.8	78	276.5	29.1
39	38.8	4.1	99	98.5	10.3	59	158.1	16.6	19	217.8	22.9	79	277.5	29.2
40	39.8	4.2	100	99.5	10.5	60	159.1	16.7	20	218.8	23.0	80	278.5	29.3
41	40.8	4.3	101	100.4	10.6	161	160.1	16.8	221	219.8	23.1	281	279.5	29.4
42	41.8	4.4	02	101.4	10.7	62	161.1	16.9	22	220.8	23.2	82	280.5	29.5
43	42.8	4.5	03	102.4	10.8	63	162.1	17.0	23	221.8	23.3	83	281.4	29.6
44	43.8	4.6	04	103.4	10.9	64	163.1	17.1	24	222.8	23.4	84	282.4	29.7
45	44.8	4.7	05	104.4	11.0	65	164.1	17.2	25	223.8	23.5	85	283.4	29.8
46	45.7	4.8	06	105.4	11.1	66	165.1	17.4	26	224.8	23.6	86	284.4	29.9
47	46.7	4.9	07	106.4	11.2	67	166.1	17.5	27	225.8	23.7	87	285.4	30.0
48	47.7	5.0	08	107.4	11.3	68	167.1	17.6	28	226.8	23.8	88	286.4	30.1
49	48.7	5.1	09	108.4	11.4	69	168.1	17.7	29	227.7	23.9	89	287.4	30.2
50	49.7	5.2	10	109.4	11.5	70	169.1	17.8	30	228.7	24.0	90	288.4	30.3
51	50.7	5.3	111	110.4	11.6	171	170.1	17.9	231	229.7	24.1	291	289.4	30.4
52	51.7	5.4	12	111.4	11.7	72	171.1	18.0	32	230.7	24.3	92	290.4	30.5
53	52.7	5.5	13	112.4	11.8	73	172.1	18.1	33	231.7	24.4	93	291.4	30.6
54	53.7	5.6	14	113.4	11.9	74	173.0	18.2	34	232.7	24.5	94	292.4	30.7
55	54.7	5.7	15	114.4	12.0	75	174.0	18.3	35	233.7	24.6	95	293.4	30.8
56	55.7	5.9	16	115.4	12.1	76	175.0	18.4	36	234.7	24.7	96	294.4	30.9
57	56.7	6.0	17	116.4	12.2	77	176.0	18.5	37	235.7	24.8	97	295.4	31.0
58	57.7	6.1	18	117.4	12.3	78	177.0	18.6	38	236.7	24.9	98	296.4	31.1
59	58.7	6.2	19	118.3	12.4	79	178.0	18.7	39	237.7	25.0	99	297.4	31.3
60	59.7	6.3	20	119.3	12.5	80	179.0	18.8	40	238.7	25.1	300	298.4	31.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

84° (96°, 264°, 276°).

TABLE 2.

Difference of Latitude and Departure for 6° (174°, 186°, 354°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	299.3	31.5	361	359.0	37.7	421	418.7	44.0	481	478.4	50.3	541	538.0	56.5
02	300.3	31.6	62	360.0	37.8	22	419.7	44.1	82	479.4	50.4	42	539.0	56.6
03	301.3	31.7	63	361.0	37.9	23	420.7	44.2	83	480.4	50.5	43	540.0	56.7
04	302.3	31.8	64	362.0	38.0	24	421.7	44.3	84	481.3	50.6	44	541.0	56.8
05	303.3	31.9	65	363.0	38.1	25	422.7	44.4	85	482.3	50.7	45	542.0	56.9
06	304.3	32.0	66	364.0	38.3	26	423.7	44.5	86	483.3	50.8	46	543.0	57.0
07	305.3	32.1	67	365.0	38.4	27	424.7	44.6	87	484.3	50.9	47	544.0	57.1
08	306.3	32.2	68	366.0	38.5	28	425.7	44.7	88	485.3	51.0	48	545.0	57.2
09	307.3	32.3	69	367.0	38.6	29	426.6	44.8	89	486.3	51.1	49	546.0	57.3
10	308.3	32.4	70	368.0	38.7	30	427.6	44.9	90	487.3	51.2	50	547.0	57.4
311	309.3	32.5	371	369.0	38.8	431	428.6	45.0	491	488.3	51.3	551	548.0	57.5
12	310.3	32.6	72	370.0	38.9	32	429.6	45.2	92	489.3	51.4	52	549.0	57.6
13	311.3	32.7	73	371.0	39.0	33	430.6	45.3	93	490.3	51.5	53	550.0	57.7
14	312.3	32.8	74	371.9	39.1	34	431.6	45.4	94	491.3	51.6	54	551.0	57.9
15	313.3	32.9	75	372.9	39.2	35	432.6	45.5	95	492.3	51.7	55	552.0	58.0
16	314.3	33.0	76	373.9	39.3	36	433.6	45.6	96	493.3	51.8	56	553.0	58.1
17	315.3	33.1	77	374.9	39.4	37	434.6	45.7	97	494.3	51.9	57	554.0	58.2
18	316.3	33.2	78	375.9	39.5	38	435.6	45.8	98	495.3	52.0	58	555.0	58.3
19	317.3	33.3	79	376.9	39.6	39	436.6	45.9	99	496.3	52.1	59	556.0	58.4
20	318.2	33.4	80	377.9	39.7	40	437.6	46.0	500	497.3	52.3	60	556.9	58.5
321	319.2	33.6	381	378.9	39.8	441	438.6	46.1	501	498.3	52.4	561	557.9	58.6
22	320.2	33.7	82	379.9	39.9	42	439.6	46.2	02	499.3	52.5	62	558.9	58.7
23	321.2	33.8	83	380.9	40.0	43	440.6	46.3	03	500.2	52.6	63	559.9	58.8
24	322.2	33.9	84	381.9	40.1	44	441.6	46.4	04	501.2	52.7	64	560.9	59.0
25	323.2	34.0	85	382.9	40.2	45	442.6	46.5	05	502.2	52.8	65	561.9	59.1
26	324.2	34.1	86	383.9	40.3	46	443.6	46.6	06	503.2	52.9	66	562.9	59.2
27	325.2	34.2	87	384.9	40.5	47	444.5	46.7	07	504.2	53.0	67	563.9	59.3
28	326.2	34.3	88	385.9	40.6	48	445.5	46.8	08	505.2	53.1	68	564.9	59.4
29	327.2	34.4	89	386.9	40.7	49	446.5	46.9	09	506.2	53.2	69	565.9	59.5
30	328.2	34.5	90	387.9	40.8	50	447.5	47.0	10	507.2	53.3	70	566.9	59.6
331	329.2	34.6	391	388.9	40.9	451	448.5	47.1	511	508.2	53.4	571	567.9	59.7
32	330.2	34.7	92	389.9	41.0	52	449.5	47.2	12	509.2	53.5	72	568.9	59.8
33	331.2	34.8	93	390.8	41.1	53	450.5	47.3	13	510.2	53.6	73	569.9	59.9
34	332.2	34.9	94	391.8	41.2	54	451.5	47.5	14	511.2	53.7	74	570.9	60.0
35	333.2	35.0	95	392.8	41.3	55	452.5	47.6	15	512.2	53.8	75	571.9	60.1
36	334.2	35.1	96	393.8	41.4	56	453.5	47.7	16	513.2	53.9	76	572.9	60.2
37	335.2	35.2	97	394.8	41.5	57	454.5	47.8	17	514.2	54.0	77	573.9	60.3
38	336.1	35.3	98	395.8	41.6	58	455.5	47.9	18	515.2	54.1	78	574.9	60.4
39	337.1	35.4	99	396.8	41.7	59	456.5	48.0	19	516.2	54.2	79	575.8	60.5
40	338.1	35.5	400	397.8	41.8	60	457.5	48.1	20	517.2	54.3	80	576.8	60.6
341	339.1	35.6	401	398.8	41.9	461	458.5	48.2	521	518.1	54.5	581	577.8	60.7
42	340.1	35.7	02	399.8	42.0	62	459.5	48.3	22	519.1	54.6	82	578.8	60.8
43	341.1	35.8	03	400.8	42.1	63	460.5	48.4	23	520.1	54.7	83	579.8	60.9
44	342.1	36.0	04	401.8	42.2	64	461.5	48.5	24	521.1	54.8	84	580.8	61.1
45	343.1	36.1	05	402.8	42.3	65	462.5	48.6	25	522.1	54.9	85	581.8	61.2
46	344.1	36.2	06	403.8	42.4	66	463.4	48.7	26	523.1	55.0	86	582.8	61.3
47	345.1	36.3	07	404.8	42.5	67	464.4	48.8	27	524.1	55.1	87	583.8	61.4
48	346.1	36.4	08	405.8	42.6	68	465.4	48.9	28	525.1	55.2	88	584.8	61.5
49	347.1	36.5	09	406.8	42.7	69	466.4	49.0	29	526.1	55.3	89	585.8	61.6
50	348.1	36.6	10	407.8	42.9	70	467.4	49.1	30	527.1	55.4	90	586.8	61.7
351	349.1	36.7	411	408.7	43.0	471	468.4	49.2	531	528.1	55.5	591	587.8	61.8
52	350.1	36.8	12	409.7	43.1	72	469.4	49.3	32	529.1	55.6	92	588.8	61.9
53	351.1	36.9	13	410.7	43.2	73	470.4	49.4	33	530.1	55.7	93	589.8	62.0
54	352.1	37.0	14	411.7	43.3	74	471.4	49.5	34	531.1	55.8	94	590.8	62.1
55	353.1	37.1	15	412.7	43.4	75	472.4	49.6	35	532.1	55.9	95	591.8	62.2
56	354.0	37.2	16	413.7	43.5	76	473.4	49.8	36	533.1	56.0	96	592.8	62.3
57	355.0	37.3	17	414.7	43.6	77	474.4	49.9	37	534.1	56.1	97	593.8	62.4
58	356.0	37.4	18	415.7	43.7	78	475.4	50.0	38	535.1	56.2	98	594.7	62.5
59	357.0	37.5	19	416.7	43.8	79	476.4	50.1	39	536.1	56.3	99	595.7	62.6
60	358.0	37.6	20	417.7	43.9	80	477.4	50.2	40	537.1	56.4	600	596.7	62.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

84° (96°, 264°, 276°).

TABLE 2.

Difference of Latitude and Departure for 7° (173°, 187°, 353°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	1.0	0.1	61	60.5	7.4	121	120.1	14.7	181	179.7	22.1	241	239.2	29.4
2	2.0	0.2	62	61.5	7.6	22	121.1	14.9	82	180.6	22.2	42	240.2	29.5
3	3.0	0.4	63	62.5	7.7	23	122.1	15.0	83	181.6	22.3	43	241.2	29.6
4	4.0	0.5	64	63.5	7.8	24	123.1	15.1	84	182.6	22.4	44	242.2	29.7
5	5.0	0.6	65	64.5	7.9	25	124.1	15.2	85	183.6	22.5	45	243.2	29.9
6	6.0	0.7	66	65.5	8.0	26	125.1	15.4	86	184.6	22.7	46	244.2	30.0
7	6.9	0.9	67	66.5	8.2	27	126.1	15.5	87	185.6	22.8	47	245.2	30.1
8	7.9	1.0	68	67.5	8.3	28	127.0	15.6	88	186.6	22.9	48	246.2	30.2
9	8.9	1.1	69	68.5	8.4	29	128.0	15.7	89	187.6	23.0	49	247.1	30.3
10	9.9	1.2	70	69.5	8.5	30	129.0	15.8	90	188.6	23.2	50	248.1	30.5
11	10.9	1.3	71	70.5	8.7	131	130.0	16.0	191	189.6	23.3	251	249.1	30.6
12	11.9	1.5	72	71.5	8.8	32	131.0	16.1	92	190.6	23.4	52	250.1	30.7
13	12.9	1.6	73	72.5	8.9	33	132.0	16.2	93	191.6	23.5	53	251.1	30.8
14	13.9	1.7	74	73.4	9.0	34	133.0	16.3	94	192.6	23.6	54	252.1	31.0
15	14.9	1.8	75	74.4	9.1	35	134.0	16.5	95	193.5	23.8	55	253.1	31.1
16	15.9	1.9	76	75.4	9.3	36	135.0	16.6	96	194.5	23.9	56	254.1	31.2
17	16.9	2.1	77	76.4	9.4	37	136.0	16.7	97	195.5	24.0	57	255.1	31.3
18	17.9	2.2	78	77.4	9.5	38	137.0	16.8	98	196.5	24.1	58	256.1	31.4
19	18.9	2.3	79	78.4	9.6	39	138.0	16.9	99	197.5	24.3	59	257.1	31.6
20	19.9	2.4	80	79.4	9.7	40	139.0	17.1	200	198.5	24.4	60	258.1	31.7
21	20.8	2.6	81	80.4	9.9	141	139.9	17.2	201	199.5	24.5	261	259.1	31.8
22	21.8	2.7	82	81.4	10.0	42	140.9	17.3	02	200.5	24.6	62	260.0	31.9
23	22.8	2.8	83	82.4	10.1	43	141.9	17.4	03	201.5	24.7	63	261.0	32.1
24	23.8	2.9	84	83.4	10.2	44	142.9	17.5	04	202.5	24.9	64	262.0	32.2
25	24.8	3.0	85	84.4	10.4	45	143.9	17.7	05	203.5	25.0	65	263.0	32.3
26	25.8	3.2	86	85.4	10.5	46	144.9	17.8	06	204.5	25.1	66	264.0	32.4
27	26.8	3.3	87	86.4	10.6	47	145.9	17.9	07	205.5	25.2	67	265.0	32.5
28	27.8	3.4	88	87.3	10.7	48	146.9	18.0	08	206.4	25.3	68	266.0	32.7
29	28.8	3.5	89	88.3	10.8	49	147.9	18.2	09	207.4	25.5	69	267.0	32.8
30	29.8	3.7	90	89.3	11.0	50	148.9	18.3	10	208.4	25.6	70	268.0	32.9
31	30.8	3.8	91	90.3	11.1	151	149.9	18.4	211	209.4	25.7	271	269.0	33.0
32	31.8	3.9	92	91.3	11.2	52	150.9	18.5	12	210.4	25.8	72	270.0	33.1
33	32.8	4.0	93	92.3	11.3	53	151.9	18.6	13	211.4	26.0	73	271.0	33.3
34	33.7	4.1	94	93.3	11.5	54	152.9	18.8	14	212.4	26.1	74	272.0	33.4
35	34.7	4.3	95	94.3	11.6	55	153.8	18.9	15	213.4	26.2	75	273.0	33.5
36	35.7	4.4	96	95.3	11.7	56	154.8	19.0	16	214.4	26.3	76	273.9	33.6
37	36.7	4.5	97	96.3	11.8	57	155.8	19.1	17	215.4	26.4	77	274.9	33.8
38	37.7	4.6	98	97.3	11.9	58	156.8	19.3	18	216.4	26.6	78	275.9	33.9
39	38.7	4.8	99	98.3	12.1	59	157.8	19.4	19	217.4	26.7	79	276.9	34.0
40	39.7	4.9	100	99.3	12.2	60	158.8	19.5	20	218.4	26.8	80	277.9	34.1
41	40.7	5.0	101	100.2	12.3	161	159.8	19.6	221	219.4	26.9	281	278.9	34.2
42	41.7	5.1	02	101.2	12.4	62	160.8	19.7	22	220.3	27.1	82	279.9	34.4
43	42.7	5.2	03	102.2	12.6	63	161.8	19.9	23	221.3	27.2	83	280.9	34.5
44	43.7	5.4	04	103.2	12.7	64	162.8	20.0	24	222.3	27.3	84	281.9	34.6
45	44.7	5.5	05	104.2	12.8	65	163.8	20.1	25	223.3	27.4	85	282.9	34.7
46	45.7	5.6	06	105.2	12.9	66	164.8	20.2	26	224.3	27.5	86	283.9	34.9
47	46.6	5.7	07	106.2	13.0	67	165.8	20.4	27	225.3	27.7	87	284.9	35.0
48	47.6	5.8	08	107.2	13.2	68	166.7	20.5	28	226.3	27.8	88	285.9	35.1
49	48.6	6.0	09	108.2	13.3	69	167.7	20.6	29	227.3	27.9	89	286.8	35.2
50	49.6	6.1	10	109.2	13.4	70	168.7	20.7	30	228.3	28.0	90	287.8	35.3
51	50.6	6.2	111	110.2	13.5	171	169.7	20.8	231	229.3	28.2	291	288.8	35.5
52	51.6	6.3	12	111.2	13.6	72	170.7	21.0	32	230.3	28.3	92	289.8	35.6
53	52.6	6.5	13	112.2	13.8	73	171.7	21.1	33	231.3	28.4	93	290.8	35.7
54	53.6	6.6	14	113.2	13.9	74	172.7	21.2	34	232.3	28.5	94	291.8	35.8
55	54.6	6.7	15	114.1	14.0	75	173.7	21.3	35	233.2	28.6	95	292.8	36.0
56	55.6	6.8	16	115.1	14.1	76	174.7	21.4	36	234.2	28.8	96	293.8	36.1
57	56.6	6.9	17	116.1	14.3	77	175.7	21.6	37	235.2	28.9	97	294.8	36.2
58	57.6	7.1	18	117.1	14.4	78	176.7	21.7	38	236.2	29.0	98	295.8	36.3
59	58.6	7.2	19	118.1	14.5	79	177.7	21.8	39	237.2	29.1	99	296.8	36.4
60	59.6	7.3	20	119.1	14.6	80	178.7	21.9	40	238.2	29.2	300	297.8	36.6
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

83° (97°, 263°, 277°).

TABLE 2.

Difference of Latitude and Departure for 7° (173°, 187°, 353°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	298.7	36.7	361	358.3	44.0	421	417.9	51.3	481	477.4	58.6	541	537.0	65.9
02	299.7	36.8	62	359.3	44.1	22	418.8	51.4	82	478.4	58.7	42	537.9	66.0
03	300.7	36.9	63	360.3	44.2	23	419.8	51.5	83	479.4	58.8	43	538.9	66.2
04	301.7	37.0	64	361.3	44.4	24	420.8	51.7	84	480.4	59.0	44	539.9	66.3
05	302.7	37.2	65	362.3	44.5	25	421.8	51.8	85	481.4	59.1	45	540.9	66.4
06	303.7	37.3	66	363.3	44.6	26	422.8	51.9	86	482.4	59.2	46	541.9	66.6
07	304.7	37.4	67	364.3	44.7	27	423.8	52.0	87	483.4	59.4	47	542.9	66.7
08	305.7	37.5	68	365.2	44.8	28	424.8	52.2	88	484.3	59.5	48	543.9	66.8
09	306.7	37.7	69	366.2	45.0	29	425.8	52.3	89	485.3	59.6	49	544.9	66.9
10	307.7	37.8	70	367.2	45.1	30	426.8	52.4	90	486.3	59.7	50	545.9	67.0
311	308.7	37.9	371	368.2	45.2	431	427.8	52.5	491	487.3	59.8	551	546.9	67.1
12	309.7	38.0	72	369.2	45.3	32	428.8	52.6	92	488.3	59.9	52	547.9	67.2
13	310.7	38.1	73	370.2	45.5	33	429.8	52.8	93	489.3	60.1	53	548.9	67.4
14	311.7	38.3	74	371.2	45.6	34	430.8	52.9	94	490.3	60.2	54	549.9	67.5
15	312.6	38.4	75	372.2	45.7	35	431.7	53.0	95	491.3	60.3	55	550.8	67.6
16	313.6	38.5	76	373.2	45.8	36	432.7	53.1	96	492.3	60.5	56	551.8	67.8
17	314.6	38.6	77	374.2	45.9	37	433.7	53.3	97	493.3	60.6	57	552.8	67.9
18	315.6	38.7	78	375.2	46.1	38	434.7	53.4	98	494.3	60.7	58	553.8	68.0
19	316.6	38.9	79	376.2	46.2	39	435.7	53.5	99	495.3	60.8	59	554.8	68.1
20	317.6	39.0	80	377.2	46.3	40	436.7	53.6	500	496.3	61.0	60	555.8	68.3
321	318.6	39.1	381	378.1	46.4	441	437.7	53.7	501	497.2	61.1	561	556.8	68.4
22	319.6	39.2	82	379.1	46.5	42	438.7	53.9	02	498.2	61.2	62	557.8	68.5
23	320.6	39.4	83	380.1	46.7	43	439.7	54.0	03	499.2	61.3	63	558.8	68.6
24	321.6	39.5	84	381.1	46.8	44	440.7	54.1	04	500.2	61.4	64	559.8	68.7
25	322.6	39.6	85	382.1	46.9	45	441.7	54.2	05	501.2	61.5	65	560.8	68.9
26	323.6	39.7	86	383.1	47.0	46	442.7	54.3	06	502.2	61.6	66	561.8	69.0
27	324.6	39.8	87	384.1	47.2	47	443.7	54.5	07	503.2	61.8	67	562.8	69.1
28	325.5	40.0	88	385.1	47.3	48	444.7	54.6	08	504.2	61.9	68	563.8	69.2
29	326.5	40.1	89	386.1	47.4	49	445.6	54.7	09	505.2	62.0	69	564.8	69.3
30	327.5	40.2	90	387.1	47.5	50	446.6	54.8	10	506.2	62.1	70	565.8	69.4
331	328.5	40.3	391	388.1	47.6	451	447.6	55.0	511	507.2	62.3	571	566.7	69.6
32	329.5	40.5	92	389.1	47.8	52	448.6	55.1	12	508.2	62.4	72	567.7	69.7
33	330.5	40.6	93	390.1	47.9	53	449.6	55.2	13	509.2	62.5	73	568.7	69.8
34	331.5	40.7	94	391.1	48.0	54	450.6	55.3	14	510.2	62.6	74	569.7	69.9
35	332.5	40.8	95	392.0	48.1	55	451.6	55.4	15	511.1	62.7	75	570.7	70.1
36	333.5	40.9	96	393.0	48.3	56	452.6	55.6	16	512.1	62.9	76	571.7	70.2
37	334.5	41.1	97	394.0	48.4	57	453.6	55.7	17	513.1	63.0	77	572.7	70.3
38	335.5	41.2	98	395.0	48.5	58	454.6	55.8	18	514.1	63.1	78	573.7	70.4
39	336.5	41.3	99	396.0	48.6	59	455.6	55.9	19	515.1	63.2	79	574.7	70.5
40	337.5	41.4	400	397.0	48.7	60	456.6	56.1	20	516.1	63.4	80	575.7	70.7
341	338.4	41.6	401	398.0	48.9	461	457.6	56.2	521	517.1	63.5	581	576.7	70.8
42	339.4	41.7	02	399.0	49.0	62	458.5	56.3	22	518.1	63.6	82	577.6	70.9
43	340.4	41.8	03	400.0	49.1	63	459.5	56.4	23	519.1	63.7	83	578.6	71.0
44	341.4	41.9	04	401.0	49.2	64	460.5	56.5	24	520.1	63.8	84	579.6	71.2
45	342.4	42.0	05	402.0	49.4	65	461.5	56.7	25	521.1	64.0	85	580.6	71.3
46	343.4	42.2	06	403.0	49.5	66	462.5	56.8	26	522.1	64.1	86	581.6	71.4
47	344.4	42.3	07	404.0	49.6	67	463.5	56.9	27	523.1	64.2	87	582.6	71.5
48	345.4	42.4	08	405.0	49.7	68	464.5	57.0	28	524.1	64.3	88	583.6	71.6
49	346.4	42.5	09	405.9	49.8	69	465.5	57.2	29	525.0	64.5	89	584.6	71.8
50	347.4	42.6	10	406.9	50.0	70	466.5	57.3	30	526.0	64.6	90	585.6	71.9
351	348.4	42.8	411	407.9	50.1	471	467.5	57.4	531	527.0	64.7	591	586.6	72.0
52	349.4	42.9	12	408.9	50.2	72	468.5	57.5	32	528.0	64.8	92	587.6	72.1
53	350.4	43.0	13	409.9	50.3	73	469.5	57.6	33	529.0	64.9	93	588.6	72.2
54	351.4	43.1	14	410.9	50.4	74	470.5	57.8	34	530.0	65.1	94	589.6	72.4
55	352.3	43.3	15	411.9	50.6	75	471.5	57.9	35	531.0	65.2	95	590.6	72.5
56	353.3	43.4	16	412.9	50.7	76	472.4	58.0	36	532.0	65.3	96	591.5	72.6
57	354.3	43.5	17	413.9	50.8	77	473.4	58.1	37	533.0	65.4	97	592.5	72.7
58	355.3	43.6	18	414.9	50.9	78	474.4	58.2	38	534.0	65.6	98	593.5	72.9
59	356.3	43.7	19	415.9	51.1	79	475.4	58.4	39	535.0	65.7	99	594.5	73.0
60	357.3	43.9	20	416.9	51.2	80	476.4	58.5	40	536.0	65.8	600	595.5	73.1
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

83° (97°, 263°, 277°).

TABLE 2.

Difference of Latitude and Departure for 8° (172°, 188°, 352°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	1.0	0.1	61	60.4	8.5	121	119.8	16.8	181	179.2	25.2	241	238.7	33.5
2	2.0	0.3	62	61.4	8.6	22	120.8	17.0	82	180.2	25.3	42	239.6	33.7
3	3.0	0.4	63	62.4	8.8	23	121.8	17.1	83	181.2	25.5	43	240.6	33.8
4	4.0	0.6	64	63.4	8.9	24	122.8	17.3	84	182.2	25.6	44	241.6	34.0
5	5.0	0.7	65	64.4	9.0	25	123.8	17.4	85	183.2	25.7	45	242.6	34.1
6	5.9	0.8	66	65.4	9.2	26	124.8	17.5	86	184.2	25.9	46	243.6	34.2
7	6.9	1.0	67	66.3	9.3	27	125.8	17.7	87	185.2	26.0	47	244.6	34.4
8	7.9	1.1	68	67.3	9.5	28	126.8	17.8	88	186.2	26.2	48	245.6	34.5
9	8.9	1.3	69	68.3	9.6	29	127.7	18.0	89	187.2	26.3	49	246.6	34.7
10	9.9	1.4	70	69.3	9.7	30	128.7	18.1	90	188.2	26.4	50	247.6	34.8
11	10.9	1.5	71	70.3	9.9	131	129.7	18.2	191	189.1	26.6	251	248.6	34.9
12	11.9	1.7	72	71.3	10.0	32	130.7	18.4	92	190.1	26.7	52	249.5	35.1
13	12.9	1.8	73	72.3	10.2	33	131.7	18.5	93	191.1	26.9	53	250.5	35.2
14	13.9	1.9	74	73.3	10.3	34	132.7	18.6	94	192.1	27.0	54	251.5	35.3
15	14.9	2.1	75	74.3	10.4	35	133.7	18.8	95	193.1	27.1	55	252.5	35.5
16	15.8	2.2	76	75.3	10.6	36	134.7	18.9	96	194.1	27.3	56	253.5	35.6
17	16.8	2.4	77	76.3	10.7	37	135.7	19.1	97	195.1	27.4	57	254.5	35.8
18	17.8	2.5	78	77.2	10.9	38	136.7	19.2	98	196.1	27.6	58	255.5	35.9
19	18.8	2.6	79	78.2	11.0	39	137.7	19.3	99	197.1	27.7	59	256.5	36.0
20	19.8	2.8	80	79.2	11.1	40	138.6	19.5	200	198.1	27.8	60	257.5	36.2
21	20.8	2.9	81	80.2	11.3	141	139.6	19.6	201	199.0	28.0	261	258.5	36.3
22	21.8	3.1	82	81.2	11.4	42	140.6	19.8	02	200.0	28.1	62	259.5	36.5
23	22.8	3.2	83	82.2	11.6	43	141.6	19.9	03	201.0	28.3	63	260.4	36.6
24	23.8	3.3	84	83.2	11.7	44	142.6	20.0	04	202.0	28.4	64	261.4	36.7
25	24.8	3.5	85	84.2	11.8	45	143.6	20.2	05	203.0	28.5	65	262.4	36.9
26	25.7	3.6	86	85.2	12.0	46	144.6	20.3	06	204.0	28.7	66	263.4	37.0
27	26.7	3.8	87	86.2	12.1	47	145.6	20.5	07	205.0	28.8	67	264.4	37.2
28	27.7	3.9	88	87.1	12.2	48	146.6	20.6	08	206.0	28.9	68	265.4	37.3
29	28.7	4.0	89	88.1	12.4	49	147.5	20.7	09	207.0	29.1	69	266.4	37.4
30	29.7	4.2	90	89.1	12.5	50	148.5	20.9	10	208.0	29.2	70	267.4	37.6
31	30.7	4.3	91	90.1	12.7	151	149.5	21.0	211	208.9	29.4	271	268.4	37.7
32	31.7	4.5	92	91.1	12.8	52	150.5	21.2	12	209.9	29.5	72	269.4	37.9
33	32.7	4.6	93	92.1	12.9	53	151.5	21.3	13	210.9	29.6	73	270.3	38.0
34	33.7	4.7	94	93.1	13.1	54	152.5	21.4	14	211.9	29.8	74	271.3	38.1
35	34.7	4.9	95	94.1	13.2	55	153.5	21.6	15	212.9	29.9	75	272.3	38.3
36	35.6	5.0	96	95.1	13.4	56	154.5	21.7	16	213.9	30.1	76	273.3	38.4
37	36.6	5.1	97	96.1	13.5	57	155.5	21.9	17	214.9	30.2	77	274.3	38.6
38	37.6	5.3	98	97.0	13.6	58	156.5	22.0	18	215.9	30.3	78	275.3	38.7
39	38.6	5.4	99	98.0	13.8	59	157.5	22.1	19	216.9	30.5	79	276.3	38.8
40	39.6	5.6	100	99.0	13.9	60	158.4	22.3	20	217.9	30.6	80	277.3	39.0
41	40.6	5.7	101	100.0	14.1	161	159.4	22.4	221	218.8	30.8	281	278.3	39.1
42	41.6	5.8	02	101.0	14.2	62	160.4	22.5	22	219.8	30.9	82	279.3	39.2
43	42.6	6.0	03	102.0	14.3	63	161.4	22.7	23	220.8	31.0	83	280.2	39.4
44	43.6	6.1	04	103.0	14.5	64	162.4	22.8	24	221.8	31.2	84	281.2	39.5
45	44.6	6.3	05	104.0	14.6	65	163.4	23.0	25	222.8	31.3	85	282.2	39.7
46	45.6	6.4	06	105.0	14.8	66	164.4	23.1	26	223.8	31.5	86	283.2	39.8
47	46.5	6.5	07	106.0	14.9	67	165.4	23.2	27	224.8	31.6	87	284.2	39.9
48	47.5	6.7	08	106.9	15.0	68	166.4	23.4	28	225.8	31.7	88	285.2	40.1
49	48.5	6.8	09	107.9	15.2	69	167.4	23.5	29	226.8	31.9	89	286.2	40.2
50	49.5	7.0	10	108.9	15.3	70	168.3	23.7	30	227.8	32.0	90	287.2	40.4
51	50.5	7.1	111	109.9	15.4	171	169.3	23.8	231	228.8	32.1	291	288.2	40.5
52	51.5	7.2	12	110.9	15.6	72	170.3	23.9	32	229.7	32.3	92	289.2	40.6
53	52.5	7.4	13	111.9	15.7	73	171.3	24.1	33	230.7	32.4	93	290.1	40.8
54	53.5	7.5	14	112.9	15.9	74	172.3	24.2	34	231.7	32.6	94	291.1	40.9
55	54.5	7.7	15	113.9	16.0	75	173.3	24.4	35	232.7	32.7	95	292.1	41.1
56	55.5	7.8	16	114.9	16.1	76	174.3	24.5	36	233.7	32.8	96	293.1	41.2
57	56.4	7.9	17	115.9	16.3	77	175.3	24.6	37	234.7	33.0	97	294.1	41.3
58	57.4	8.1	18	116.9	16.4	78	176.3	24.8	38	235.7	33.1	98	295.1	41.5
59	58.4	8.2	19	117.8	16.6	79	177.3	24.9	39	236.7	33.3	99	296.1	41.6
60	59.4	8.4	20	118.8	16.7	80	178.2	25.1	40	237.7	33.4	300	297.1	41.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

82° (98°, 262°, 278°).

TABLE 2.

Difference of Latitude and Departure for 8° (172°, 188°, 352°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	298.0	41.9	361	357.5	50.2	421	416.9	58.6	481	476.3	66.9	541	535.7	75.2
02	299.0	42.0	62	358.5	50.4	22	417.9	58.7	82	477.3	67.1	42	536.7	75.4
03	300.0	42.2	63	359.4	50.5	23	418.9	58.9	83	478.3	67.2	43	537.7	75.5
04	301.0	42.3	64	360.4	50.7	24	419.8	59.0	84	479.3	67.4	44	538.7	75.7
05	302.0	42.5	65	361.4	50.8	25	420.8	59.2	85	480.3	67.5	45	539.7	75.8
06	303.0	42.6	66	362.4	50.9	26	421.8	59.3	86	481.2	67.6	46	540.6	75.9
07	304.0	42.7	67	363.4	51.1	27	422.8	59.4	87	482.2	67.8	47	541.6	76.1
08	305.0	42.9	68	364.4	51.2	28	423.8	59.6	88	483.2	67.9	48	542.6	76.2
09	306.0	43.0	69	365.4	51.4	29	424.8	59.7	89	484.2	68.1	49	543.6	76.4
10	307.0	43.1	70	366.4	51.5	30	425.8	59.8	90	485.2	68.2	50	544.6	76.5
311	307.9	43.3	371	367.4	51.6	431	426.8	60.0	491	486.2	68.3	551	545.6	76.6
12	308.9	43.4	72	368.4	51.8	32	427.8	60.1	92	487.2	68.5	52	546.6	76.8
13	309.9	43.6	73	369.3	51.9	33	428.8	60.3	93	488.2	68.6	53	547.6	76.9
14	310.9	43.7	74	370.3	52.1	34	429.8	60.4	94	489.2	68.8	54	548.6	77.1
15	311.9	43.8	75	371.3	52.2	35	430.7	60.5	95	490.2	68.9	55	549.6	77.2
16	312.9	44.0	76	372.3	52.3	36	431.7	60.7	96	491.2	69.0	56	550.6	77.4
17	313.9	44.1	77	373.3	52.5	37	432.7	60.8	97	492.1	69.2	57	551.5	77.5
18	314.9	44.3	78	374.3	52.6	38	433.7	61.0	98	493.1	69.3	58	552.5	77.6
19	315.9	44.4	79	375.3	52.7	39	434.7	61.1	99	494.1	69.5	59	553.5	77.8
20	316.9	44.5	80	376.3	52.9	40	435.7	61.2	500	495.1	69.6	60	554.5	77.9
321	317.9	44.7	381	377.3	53.0	441	436.7	61.4	501	496.1	69.7	561	555.5	78.1
22	318.8	44.8	82	378.3	53.2	42	437.7	61.5	02	497.1	69.9	62	556.5	78.2
23	319.8	45.0	83	379.2	53.3	43	438.7	61.7	03	498.1	70.0	63	557.5	78.3
24	320.8	45.1	84	380.2	53.4	44	439.7	61.8	04	499.1	70.2	64	558.5	78.5
25	321.8	45.2	85	381.2	53.6	45	440.6	61.9	05	500.1	70.3	65	559.5	78.6
26	322.8	45.4	86	382.2	53.7	46	441.6	62.1	06	501.0	70.4	66	560.5	78.8
27	323.8	45.5	87	383.2	53.9	47	442.6	62.2	07	502.0	70.6	67	561.5	78.9
28	324.8	45.7	88	384.2	54.0	48	443.6	62.4	08	503.0	70.7	68	562.5	79.0
29	325.8	45.8	89	385.2	54.1	49	444.6	62.5	09	504.0	70.8	69	563.5	79.1
30	326.8	45.9	90	386.2	54.3	50	445.6	62.6	10	505.0	70.9	70	564.5	79.3
331	327.8	46.1	391	387.2	54.4	451	446.6	62.8	511	506.0	71.1	571	565.4	79.4
32	328.7	46.2	92	388.2	54.6	52	447.6	62.9	12	507.0	71.2	72	566.4	79.6
33	329.7	46.3	93	389.1	54.7	53	448.6	63.0	13	508.0	71.4	73	567.4	79.7
34	330.7	46.5	94	390.1	54.8	54	449.6	63.2	14	509.0	71.5	74	568.4	79.8
35	331.7	46.6	95	391.1	55.0	55	450.5	63.3	15	510.0	71.6	75	569.4	80.0
36	332.7	46.8	96	392.1	55.1	56	451.5	63.5	16	510.9	71.8	76	570.4	80.1
37	333.7	46.9	97	393.1	55.3	57	452.5	63.6	17	511.9	71.9	77	571.4	80.2
38	334.7	47.0	98	394.1	55.4	58	453.5	63.7	18	512.9	72.0	78	572.4	80.4
39	335.7	47.2	99	395.1	55.5	59	454.5	63.9	19	513.9	72.2	79	573.4	80.5
40	336.7	47.3	400	396.1	55.7	60	455.5	64.0	20	514.9	72.3	80	574.4	80.6
341	337.7	47.5	401	397.1	55.8	461	456.5	64.2	521	515.9	72.4	581	575.4	80.8
42	338.6	47.6	02	398.1	56.0	62	457.5	64.3	22	516.9	72.6	82	576.4	80.9
43	339.6	47.7	03	399.1	56.1	63	458.5	64.4	23	517.9	72.8	83	577.4	81.1
44	340.6	47.9	04	400.0	56.2	64	459.5	64.6	24	518.9	73.0	84	578.4	81.3
45	341.6	48.0	05	401.0	56.4	65	460.4	64.7	25	519.9	73.1	85	579.4	81.4
46	342.6	48.2	06	402.0	56.5	66	461.4	64.9	26	520.9	73.2	86	580.3	81.6
47	343.6	48.3	07	403.0	56.6	67	462.4	65.0	27	521.8	73.4	87	581.3	81.7
48	344.6	48.4	08	404.0	56.8	68	463.4	65.1	28	522.8	73.5	88	582.3	81.8
49	345.6	48.6	09	405.0	56.9	69	464.4	65.3	29	523.8	73.7	89	583.3	82.0
50	346.6	48.7	10	406.0	57.1	70	465.4	65.4	30	524.8	73.8	90	584.3	82.1
351	347.6	48.9	411	407.0	57.2	471	466.4	65.6	531	525.8	73.9	591	585.3	82.2
52	348.5	49.0	12	408.0	57.3	72	467.4	65.7	32	526.8	74.1	92	586.3	82.4
53	349.5	49.1	13	409.0	57.5	73	468.4	65.8	33	527.8	74.2	93	587.3	82.5
54	350.5	49.3	14	409.9	57.6	74	469.4	66.0	34	528.8	74.3	94	588.3	82.6
55	351.5	49.4	15	410.9	57.8	75	470.4	66.1	35	529.8	74.5	95	589.3	82.8
56	352.5	49.5	16	411.9	57.9	76	471.3	66.2	36	530.8	74.6	96	590.3	83.0
57	353.5	49.7	17	412.9	58.0	77	472.3	66.4	37	531.7	74.7	97	591.2	83.1
58	354.5	49.8	18	413.9	58.2	78	473.3	66.5	38	532.7	74.9	98	592.2	83.2
59	355.5	50.0	19	414.9	58.3	79	474.3	66.7	39	533.7	75.0	99	593.2	83.3
60	356.5	50.1	20	415.9	58.5	80	475.3	66.8	40	534.7	75.1	600	594.2	83.5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

82° (98°, 262°, 278°).

TABLE 2.

Difference of Latitude and Departure for 9° (171°, 189°, 351°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	1.0	0.2	61	60.2	9.5	121	119.5	18.9	181	178.8	28.3	241	238.0	37.7
2	2.0	0.3	62	61.2	9.7	22	120.5	19.1	82	179.8	28.5	42	239.0	37.9
3	3.0	0.5	63	62.2	9.9	23	121.5	19.2	83	180.7	28.6	43	240.0	38.0
4	4.0	0.6	64	63.2	10.0	24	122.5	19.4	84	181.7	28.8	44	241.0	38.2
5	4.9	0.8	65	64.2	10.2	25	123.5	19.6	85	182.7	28.9	45	242.0	38.3
6	5.9	0.9	66	65.2	10.3	26	124.4	19.7	86	183.7	29.1	46	243.0	38.5
7	6.9	1.1	67	66.2	10.5	27	125.4	19.9	87	184.7	29.3	47	244.0	38.6
8	7.9	1.3	68	67.2	10.6	28	126.4	20.0	88	185.7	29.4	48	244.9	38.8
9	8.9	1.4	69	68.2	10.8	29	127.4	20.2	89	186.7	29.6	49	245.9	39.0
10	9.9	1.6	70	69.1	11.0	30	128.4	20.3	90	187.7	29.7	50	246.9	39.1
11	10.9	1.7	71	70.1	11.1	131	129.4	20.5	191	188.6	29.9	251	247.9	39.3
12	11.9	1.9	72	71.1	11.3	32	130.4	20.6	92	189.6	30.0	52	248.9	39.4
13	12.8	2.0	73	72.1	11.4	33	131.4	20.8	93	190.6	30.2	53	249.9	39.6
14	13.8	2.2	74	73.1	11.6	34	132.4	21.0	94	191.6	30.3	54	250.9	39.7
15	14.8	2.3	75	74.1	11.7	35	133.3	21.1	95	192.6	30.5	55	251.9	39.9
16	15.8	2.5	76	75.1	11.9	36	134.3	21.3	96	193.6	30.7	56	252.8	40.0
17	16.8	2.7	77	76.1	12.0	37	135.3	21.4	97	194.6	30.8	57	253.8	40.2
18	17.8	2.8	78	77.0	12.2	38	136.3	21.6	98	195.6	31.0	58	254.8	40.4
19	18.8	3.0	79	78.0	12.4	39	137.3	21.7	99	196.5	31.1	59	255.8	40.5
20	19.8	3.1	80	79.0	12.5	40	138.3	21.9	200	197.5	31.3	60	256.8	40.7
21	20.7	3.3	81	80.0	12.7	141	139.3	22.1	201	198.5	31.4	261	257.8	40.8
22	21.7	3.4	82	81.0	12.8	42	140.3	22.2	02	199.5	31.6	62	258.8	41.0
23	22.7	3.6	83	82.0	13.0	43	141.2	22.4	03	200.5	31.8	63	259.8	41.1
24	23.7	3.8	84	83.0	13.1	44	142.2	22.5	04	201.5	31.9	64	260.7	41.3
25	24.7	3.9	85	84.0	13.3	45	143.2	22.7	05	202.5	32.1	65	261.7	41.5
26	25.7	4.1	86	84.9	13.5	46	144.2	22.8	06	203.5	32.2	66	262.7	41.6
27	26.7	4.2	87	85.9	13.6	47	145.2	23.0	07	204.5	32.4	67	263.7	41.8
28	27.7	4.4	88	86.9	13.8	48	146.2	23.2	08	205.4	32.5	68	264.7	41.9
29	28.6	4.5	89	87.9	13.9	49	147.2	23.3	09	206.4	32.7	69	265.7	42.1
30	29.6	4.7	90	88.9	14.1	50	148.2	23.5	10	207.4	32.9	70	266.7	42.2
31	30.6	4.8	91	89.9	14.2	151	149.1	23.6	211	208.4	33.0	271	267.7	42.4
32	31.6	5.0	92	90.9	14.4	52	150.1	23.8	12	209.4	33.2	72	268.7	42.6
33	32.6	5.2	93	91.9	14.5	53	151.1	23.9	13	210.4	33.3	73	269.6	42.7
34	33.6	5.3	94	92.8	14.7	54	152.1	24.1	14	211.4	33.5	74	270.6	42.9
35	34.6	5.5	95	93.8	14.9	55	153.1	24.2	15	212.4	33.6	75	271.6	43.0
36	35.6	5.6	96	94.8	15.0	56	154.1	24.4	16	213.3	33.8	76	272.6	43.2
37	36.5	5.8	97	95.8	15.2	57	155.1	24.6	17	214.3	33.9	77	273.6	43.3
38	37.5	5.9	98	96.8	15.3	58	156.1	24.7	18	215.3	34.1	78	274.6	43.5
39	38.5	6.1	99	97.8	15.5	59	157.0	24.9	19	216.3	34.3	79	275.6	43.6
40	39.5	6.3	100	98.8	15.6	60	158.0	25.0	20	217.3	34.4	80	276.6	43.8
41	40.5	6.4	101	99.8	15.8	161	159.0	25.2	221	218.3	34.6	281	277.5	44.0
42	41.5	6.6	02	100.7	16.0	62	160.0	25.3	22	219.3	34.7	82	278.5	44.1
43	42.5	6.7	03	101.7	16.1	63	161.0	25.5	23	220.3	34.9	83	279.5	44.3
44	43.5	6.9	04	102.7	16.3	64	162.0	25.7	24	221.2	35.0	84	280.5	44.4
45	44.4	7.0	05	103.7	16.4	65	163.0	25.8	25	222.2	35.2	85	281.5	44.6
46	45.4	7.2	06	104.7	16.6	66	164.0	26.0	26	223.2	35.4	86	282.5	44.7
47	46.4	7.4	07	105.7	16.7	67	164.9	26.1	27	224.2	35.5	87	283.5	44.9
48	47.4	7.5	08	106.7	16.9	68	165.9	26.3	28	225.2	35.7	88	284.5	45.1
49	48.4	7.7	09	107.7	17.1	69	166.9	26.4	29	226.2	35.8	89	285.4	45.2
50	49.4	7.8	10	108.6	17.2	70	167.9	26.6	30	227.2	36.0	90	286.4	45.4
51	50.4	8.0	111	109.6	17.4	171	168.9	26.8	231	228.2	36.1	291	287.4	45.5
52	51.4	8.1	12	110.6	17.5	72	169.9	26.9	32	229.1	36.3	92	288.4	45.7
53	52.3	8.3	13	111.6	17.7	73	170.9	27.1	33	230.1	36.4	93	289.4	45.8
54	53.3	8.4	14	112.6	17.8	74	171.9	27.2	34	231.1	36.6	94	290.4	46.0
55	54.3	8.6	15	113.6	18.0	75	172.8	27.4	35	232.1	36.8	95	291.4	46.1
56	55.3	8.8	16	114.6	18.1	76	173.8	27.5	36	233.1	36.9	96	292.4	46.3
57	56.3	8.9	17	115.6	18.3	77	174.8	27.7	37	234.1	37.1	97	293.3	46.5
58	57.3	9.1	18	116.5	18.5	78	175.8	27.8	38	235.1	37.2	98	294.3	46.6
59	58.3	9.2	19	117.5	18.6	79	176.8	28.0	39	236.1	37.4	99	295.3	46.8
60	59.3	9.4	20	118.5	18.8	80	177.8	28.2	40	237.0	37.5	300	296.3	46.9
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

81° (99°, 261°, 279°).

TABLE 2.

Difference of Latitude and Departure for 9° (171°, 189°, 351°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	297.3	47.1	361	356.6	56.5	421	415.8	65.9	481	475.1	75.2	541	534.4	84.6
02	298.3	47.2	62	357.5	56.7	22	416.8	66.0	82	476.1	75.3	42	535.4	84.7
03	299.3	47.4	63	358.5	56.8	23	417.8	66.2	83	477.1	75.5	43	536.3	84.9
04	300.3	47.6	64	359.5	56.9	24	418.8	66.3	84	478.0	75.6	44	537.3	85.1
05	301.2	47.7	65	360.5	57.1	25	419.8	66.5	85	479.0	75.8	45	538.3	85.3
06	302.2	47.9	66	361.5	57.3	26	420.8	66.6	86	480.0	75.9	46	539.3	85.4
07	303.2	48.0	67	362.5	57.4	27	421.7	66.8	87	481.0	76.1	47	540.3	85.6
08	304.2	48.2	68	363.5	57.6	28	422.7	67.0	88	482.0	76.2	48	541.3	85.7
09	305.2	48.3	69	364.5	57.7	29	423.7	67.1	89	483.0	76.4	49	542.3	85.9
10	306.2	48.5	70	365.4	57.9	30	424.7	67.3	90	484.0	76.5	50	543.3	86.0
311	307.2	48.7	371	366.4	58.1	431	425.7	67.4	491	485.0	76.7	551	544.3	86.2
12	308.2	48.8	72	367.4	58.2	32	426.7	67.6	92	485.9	76.8	52	545.2	86.3
13	309.1	49.0	73	368.4	58.4	33	427.7	67.7	93	486.9	77.0	53	546.2	86.5
14	310.1	49.1	74	369.4	58.5	34	428.7	67.9	94	487.9	77.1	54	547.2	86.6
15	311.1	49.3	75	370.4	58.7	35	429.6	68.1	95	488.9	77.3	55	548.2	86.8
16	312.1	49.4	76	371.4	58.8	36	430.6	68.2	96	489.9	77.5	56	549.2	87.0
17	313.1	49.6	77	372.4	59.0	37	431.6	68.4	97	490.9	77.7	57	550.2	87.1
18	314.1	49.8	78	373.3	59.1	38	432.6	68.5	98	491.9	77.9	58	551.2	87.3
19	315.1	49.9	79	374.3	59.3	39	433.6	68.7	99	492.9	78.0	59	552.2	87.4
20	316.1	50.1	80	375.3	59.5	40	434.6	68.8	500	493.8	78.2	60	553.1	87.6
321	317.0	50.2	381	376.3	59.6	441	435.6	69.0	501	494.8	78.4	561	554.1	87.7
22	318.0	50.4	82	377.3	59.8	42	436.6	69.1	02	495.8	78.5	62	555.1	87.9
23	319.0	50.5	83	378.3	59.9	43	437.5	69.3	03	496.8	78.7	63	556.1	88.0
24	320.0	50.7	84	379.3	60.1	44	438.5	69.5	04	497.8	78.8	64	557.1	88.2
25	321.0	50.8	85	380.3	60.2	45	439.5	69.6	05	498.8	79.0	65	558.1	88.3
26	322.0	51.0	86	381.2	60.4	46	440.5	69.8	06	499.8	79.1	66	559.1	88.5
27	323.0	51.2	87	382.2	60.5	47	441.5	69.9	07	500.8	79.2	67	560.1	88.6
28	324.0	51.3	88	383.2	60.7	48	442.5	70.1	08	501.7	79.4	68	561.0	88.8
29	324.9	51.5	89	384.2	60.9	49	443.5	70.2	09	502.7	79.5	69	562.0	88.9
30	325.9	51.7	90	385.2	61.0	50	444.5	70.4	10	503.7	79.7	70	563.0	89.1
331	326.9	51.8	391	386.2	61.2	451	445.4	70.6	511	504.7	79.8	571	564.0	89.2
32	327.9	51.9	92	387.2	61.3	52	446.4	70.7	12	505.7	80.1	72	565.0	89.4
33	328.9	52.1	93	388.2	61.5	53	447.4	70.9	13	506.7	80.2	73	566.0	89.5
34	329.9	52.3	94	389.1	61.6	54	448.4	71.0	14	507.7	80.3	74	567.0	89.7
35	330.9	52.4	95	390.1	61.8	55	449.4	71.2	15	508.7	80.5	75	568.0	89.9
36	331.9	52.6	96	391.1	62.0	56	450.4	71.3	16	509.6	80.6	76	568.9	90.1
37	332.8	52.7	97	392.1	62.1	57	451.4	71.5	17	510.6	80.8	77	569.9	90.2
38	333.8	52.9	98	393.1	62.3	58	452.4	71.7	18	511.6	80.9	78	570.9	90.3
39	334.8	53.0	99	394.1	62.4	59	453.3	71.8	19	512.6	81.1	79	571.9	90.5
40	335.8	53.2	400	395.1	62.6	60	454.3	72.0	20	513.6	81.3	80	572.9	90.7
341	336.8	53.3	401	396.1	62.7	461	455.3	72.1	521	514.6	81.4	581	573.9	90.9
42	337.8	53.5	02	397.0	62.9	62	456.3	72.3	22	515.6	81.6	82	574.9	91.0
43	338.8	53.7	03	398.0	63.0	63	457.3	72.4	23	516.6	81.8	83	575.9	91.2
44	339.8	53.8	04	399.0	63.2	64	458.3	72.6	24	517.6	81.9	84	576.9	91.3
45	340.8	54.0	05	400.0	63.4	65	459.3	72.7	25	518.6	82.1	85	577.9	91.5
46	341.7	54.1	06	401.0	63.5	66	460.3	72.9	26	519.5	82.3	86	578.8	91.7
47	342.7	54.3	07	402.0	63.7	67	461.2	73.1	27	520.5	82.4	87	579.8	91.8
48	343.7	54.4	08	403.0	63.8	68	462.2	73.2	28	521.5	82.6	88	580.8	92.0
49	344.7	54.6	09	404.0	64.0	69	463.2	73.4	29	522.5	82.7	89	581.8	92.1
50	345.7	54.8	10	405.0	64.1	70	464.2	73.5	30	523.5	82.9	90	582.8	92.2
351	346.7	54.9	411	405.9	64.3	471	465.2	73.7	531	524.5	83.1	591	583.8	92.4
52	347.7	55.1	12	406.9	64.5	72	466.2	73.8	32	525.5	83.2	92	584.8	92.5
53	348.7	55.2	13	407.9	64.6	73	467.2	74.0	33	526.5	83.4	93	585.7	92.7
54	349.6	55.4	14	408.9	64.8	74	468.2	74.2	34	527.5	83.5	94	586.7	92.9
55	350.6	55.5	15	409.9	64.9	75	469.2	74.3	35	528.4	83.7	95	587.7	93.1
56	351.6	55.7	16	410.9	65.1	76	470.1	74.5	36	529.4	83.8	96	588.7	93.2
57	352.6	55.9	17	411.9	65.2	77	471.1	74.6	37	530.4	84.0	97	589.7	93.4
58	353.6	56.0	18	412.9	65.4	78	472.1	74.8	38	531.4	84.1	98	590.7	93.5
59	354.6	56.2	19	413.8	65.6	79	473.1	74.9	39	532.4	84.3	99	591.7	93.7
60	355.6	56.3	20	414.8	65.7	80	474.1	75.0	40	533.4	84.4	600	592.6	93.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

81° (99°, 261°, 279°).

TABLE 2.

Difference of Latitude and Departure for 10° (170°, 190°, 350°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	1.0	0.2	61	60.1	10.6	121	119.2	21.0	181	178.3	31.4	241	237.3	41.8
2	2.0	0.3	62	61.1	10.8	22	120.1	21.2	82	179.2	31.6	42	238.3	42.0
3	3.0	0.5	63	62.0	10.9	23	121.1	21.4	83	180.2	31.8	43	239.3	42.2
4	3.9	0.7	64	63.0	11.1	24	122.1	21.5	84	181.2	32.0	44	240.3	42.4
5	4.9	0.9	65	64.0	11.3	25	123.1	21.7	85	182.2	32.1	45	241.3	42.5
6	5.9	1.0	66	65.0	11.5	26	124.1	21.9	86	183.2	32.3	46	242.3	42.7
7	6.9	1.2	67	66.0	11.6	27	125.1	22.1	87	184.2	32.5	47	243.2	42.9
8	7.9	1.4	68	67.0	11.8	28	126.1	22.2	88	185.1	32.6	48	244.2	43.1
9	8.9	1.6	69	68.0	12.0	29	127.0	22.4	89	186.1	32.8	49	245.2	43.2
10	9.8	1.7	70	68.9	12.2	30	128.0	22.6	90	187.1	33.0	50	246.2	43.4
11	10.8	1.9	71	69.9	12.3	131	129.0	22.7	191	188.1	33.2	251	247.2	43.6
12	11 8	2.1	72	70.9	12.5	32	130.0	22.9	92	189.1	33.3	52	248.2	43.8
13	12.8	2.3	73	71.9	12.7	33	131.0	23.1	93	190.1	33.5	53	249.2	43.9
14	13.8	2.4	74	72.9	12.8	34	132.0	23.3	94	191.1	33.7	54	250.1	44.1
15	14.8	2.6	75	73.9	13.0	35	132.9	23.4	95	192.0	33.9	55	251.1	44.3
16	15.8	2.8	76	74.8	13.2	36	133.9	23.6	96	193.0	34.0	56	252.1	44.5
17	16.7	3.0	77	75.8	13.4	37	134.9	23.8	97	194.0	34.2	57	253.1	44.6
18	17.7	3.1	78	76.8	13.5	38	135.9	24.0	98	195.0	34.4	58	254.1	44.8
19	18.7	3.3	79	77.8	13.7	39	136.9	24.1	99	196.0	34.6	59	255.1	45.0
20	19.7	3.5	80	78.8	13.9	40	137.9	24.3	200	197.0	34.7	60	256.1	45.1
21	20.7	3.6	81	79.8	14.1	141	138.9	24.5	201	197.9	34.9	261	257.0	45.3
22	21.7	3.8	82	80.8	14.2	42	139.8	24.7	02	198.9	35.1	62	258.0	45.5
23	22.7	4.0	83	81.7	14.4	43	140.8	24.8	03	199.9	35.3	63	259.0	45.7
24	23.6	4.2	84	82.7	14.6	44	141.8	25.0	04	200.9	35.4	64	260.0	45.8
25	24.6	4.3	85	83.7	14.8	45	142.8	25.2	05	201.9	35.6	65	261.0	46.0
26	25.6	4.5	86	84.7	14.9	46	143.8	25.4	06	202.9	35.8	66	262.0	46.2
27	26.6	4.7	87	85.7	15.1	47	144.8	25.5	07	203.9	35.9	67	262.9	46.4
28	27.6	4.9	88	86.7	15.3	48	145.8	25.7	08	204.8	36.1	68	263.9	46.5
29	28.6	5.0	89	87.6	15.5	49	146.7	25.9	09	205.8	36.3	69	264.9	46.7
30	29.5	5.2	90	88.6	15.6	50	147.7	26.0	10	206.8	36.5	70	265.9	46.9
31	30.5	5.4	91	89.6	15.8	151	148.7	26.2	211	207.8	36.6	271	266.9	47.1
32	31.5	5.6	92	90.6	16.0	52	149.7	26.4	12	208.8	36.8	72	267.9	47.2
33	32.5	5.7	93	91.6	16.1	53	150.7	26.6	13	209.8	37.0	73	268.9	47.4
34	33.5	5.9	94	92.6	16.3	54	151.7	26.7	14	210.7	37.2	74	269.8	47.6
35	34.5	6.1	95	93.6	16.5	55	152.6	26.9	15	211.7	37.3	75	270.8	47.8
36	35.5	6.3	96	94.5	16.7	56	153.6	27.1	16	212.7	37.5	76	271.8	47.9
37	36.4	6.4	97	95.5	16.8	57	154.6	27.3	17	213.7	37.7	77	272.8	48.1
38	37.4	6.6	98	96.5	17.0	58	155.6	27.4	18	214.7	37.9	78	273.8	48.3
39	38.4	6.8	99	97.5	17.2	59	156.6	27.6	19	215.7	38.0	79	274.8	48.4
40	39.4	6.9	100	98.5	17.4	60	157.6	27.8	20	216.7	38.2	80	275.7	48.6
41	40.4	7.1	101	99.5	17.5	161	158.6	28.0	221	217.6	38.4	281	276.7	48.8
42	41.4	7.3	02	100.5	17.7	62	159.5	28.1	22	218.6	38.5	82	277.7	49.0
43	42.3	7.5	03	101.4	17.9	63	160.5	28.3	23	219.6	38.7	83	278.7	49.1
44	43.3	7.6	04	102.4	18.1	64	161.5	28.5	24	220.6	38.9	84	279.7	49.3
45	44.3	7.8	05	103.4	18.2	65	162.5	28.7	25	221.6	39.1	85	280.7	49.5
46	45.3	8.0	06	104.4	18.4	66	163.5	28.8	26	222.6	39.2	86	281.7	49.7
47	46.3	8.2	07	105.4	18.6	67	164.5	29.0	27	223.6	39.4	87	282.6	49.8
48	47.3	8.3	08	106.4	18.8	68	165.4	29.2	28	224.5	39.6	88	283.6	50.0
49	48.3	8.5	09	107.3	18.9	69	166.4	29.3	29	225.5	39.8	89	284.6	50.2
50	49.2	8.7	10	108.3	19.1	70	167.4	29.5	30	226.5	39.9	90	285.6	50.4
51	50.2	8.9	111	109.3	19.3	171	168.4	29.7	231	227.5	40.1	291	286.6	50.5
52	51.2	9.0	12	110.3	19.4	72	169.4	29.9	32	228.5	40.3	92	287.6	50.7
53	52.2	9.2	13	111.3	19.6	73	170.4	30.0	33	229.5	40.5	93	288.5	50.9
54	53.2	9.4	14	112.3	19.8	74	171.4	30.2	34	230.4	40.6	94	289.5	51.1
55	54.2	9.6	15	113.3	20.0	75	172.3	30.4	35	231.4	40.8	95	290.5	51.2
56	55.1	9.7	16	114.2	20.1	76	173.3	30.6	36	232.4	41.0	96	291.5	51.4
57	56.1	9.9	17	115.2	20.3	77	174.3	30.7	37	233.4	41.2	97	292.5	51.6
58	57.1	10.1	18	116.2	20.5	78	175.3	30.9	38	234.4	41.3	98	293.5	51.7
59	58.1	10.2	19	117.2	20.7	79	176.3	31.1	39	235.4	41.5	99	294.5	51.9
60	59.1	10.4	20	118.2	20.8	80	177.3	31.3	40	236.4	41.7	300	295.4	52.1
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

80° (100°, 260°, 280°).

TABLE 2.

Difference of Latitude and Departure for 10° (170°, 190°, 350°)

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	296.4	52.3	361	355.5	62.7	421	414.6	73.1	481	473.7	83.5	541	532.8	93.
02	297.4	52.5	62	356.5	62.9	22	415.6	73.3	82	474.7	83.7	42	533.8	94.
03	298.4	52.6	63	357.5	63.0	23	416.6	73.5	83	475.7	83.9	43	534.8	94.
04	299.4	52.8	64	358.5	63.2	24	417.6	73.6	84	476.6	84.1	44	535.7	94.
05	300.4	53.0	65	359.5	63.4	25	418.5	73.8	85	477.6	84.2	45	536.7	94.
06	301.4	53.1	66	360.4	63.6	26	419.5	74.0	86	478.6	84.4	46	537.7	94.
07	302.3	53.3	67	361.4	63.7	27	420.5	74.2	87	479.6	84.6	47	538.7	95.
08	303.3	53.5	68	362.4	63.9	28	421.5	74.3	88	480.6	84.7	48	539.7	95.
09	304.3	53.7	69	363.4	64.1	29	422.5	74.5	89	481.6	84.9	49	540.7	95.
10	305.3	53.8	70	364.4	64.3	30	423.5	74.7	90	482.6	85.1	50	541.6	95.
311	306.3	54.0	371	365.4	64.4	431	424.5	74.9	491	483.5	85.2	551	542.6	95.
12	307.3	54.2	72	366.4	64.6	32	425.4	75.0	92	484.5	85.4	52	543.6	95.
13	308.2	54.3	73	367.3	64.8	33	426.4	75.2	93	485.5	85.6	53	544.6	96.
14	309.2	54.5	74	368.3	65.0	34	427.4	75.4	94	486.5	85.8	54	545.6	96.
15	310.2	54.7	75	369.3	65.1	35	428.4	75.5	95	487.5	85.9	55	546.6	96.
16	311.2	54.9	76	370.3	65.3	36	429.4	75.7	96	488.5	86.1	56	547.5	96.
17	312.2	55.1	77	371.3	65.5	37	430.4	75.9	97	489.4	86.3	57	548.5	96.
18	313.2	55.2	78	372.3	65.6	38	431.3	76.1	98	490.4	86.5	58	549.5	96.
19	314.2	55.4	79	373.2	65.8	39	432.3	76.2	99	491.4	86.6	59	550.5	97.
20	315.1	55.6	80	374.2	66.0	40	433.3	76.4	500	492.4	86.8	60	551.5	97.
321	316.1	55.8	381	375.2	66.2	441	434.3	76.6	501	493.4	87.0	561	552.5	97.
22	317.1	55.9	82	376.2	66.3	42	435.3	76.8	02	494.4	87.2	62	553.5	97.
23	318.1	56.1	83	377.2	66.5	43	436.3	76.9	03	495.3	87.3	63	554.4	97.
24	319.1	56.3	84	378.2	66.7	44	437.3	77.1	04	496.3	87.5	64	555.4	97.
25	320.1	56.4	85	379.2	66.9	45	438.2	77.3	05	497.3	87.7	65	556.4	98.
26	321.0	56.6	86	380.1	67.0	46	439.2	77.5	06	498.3	87.9	66	557.4	98.
27	322.0	56.8	87	381.1	67.2	47	440.2	77.6	07	499.3	88.0	67	558.4	98.
28	323.0	57.0	88	382.1	67.4	48	441.2	77.8	08	500.3	88.2	68	559.4	98.
29	324.0	57.1	89	383.1	67.6	49	442.2	78.0	09	501.3	88.4	69	560.3	98.
30	325.0	57.3	90	384.1	67.7	50	443.2	78.2	10	502.2	88.6	70	561.3	99.
331	326.0	57.5	391	385.1	67.9	451	444.2	78.3	511	503.2	88.7	571	562.3	99.
32	327.0	57.7	92	386.0	68.1	52	445.1	78.5	12	504.2	88.9	72	563.3	99.
33	327.9	57.8	93	387.0	68.2	53	446.1	78.7	13	505.2	89.1	73	564.3	99.
34	328.9	58.0	94	388.0	68.4	54	447.1	78.8	14	506.2	89.2	74	565.3	99.
35	329.9	58.2	95	389.0	68.6	55	448.1	79.0	15	507.2	89.4	75	566.3	99.
36	330.9	58.4	96	390.0	68.8	56	449.1	79.2	16	508.2	89.6	76	567.2	100.
37	331.9	58.5	97	391.0	68.9	57	450.1	79.4	17	509.1	89.8	77	568.2	100.
38	332.9	58.7	98	392.0	69.1	58	451.0	79.5	18	510.1	89.9	78	569.2	100.
39	333.9	58.9	99	392.9	69.3	59	452.0	79.7	19	511.1	90.1	79	570.2	100.
40	334.8	59.1	400	393.9	69.5	60	453.0	79.9	20	512.1	90.3	80	571.2	100.
341	335.8	59.2	401	394.9	69.6	461	454.0	80.1	521	513.1	90.5	581	572.2	100.
42	336.8	59.4	02	395.9	69.8	62	455.0	80.2	22	514.1	90.6	82	573.2	101.
43	337.8	59.6	03	396.9	70.0	63	456.0	80.4	23	515.1	90.8	83	574.1	101.
44	338.8	59.8	04	397.9	70.2	64	457.0	80.6	24	516.0	91.0	84	575.1	101.
45	339.8	59.9	05	398.9	70.3	65	457.9	80.8	25	517.0	91.2	85	576.1	101.
46	340.7	60.1	06	399.8	70.5	66	458.9	80.9	26	518.0	91.3	86	577.1	101.
47	341.7	60.3	07	400.8	70.7	67	459.9	81.1	27	519.0	91.5	87	578.1	101.
48	342.7	60.4	08	401.8	70.9	68	460.9	81.3	28	520.0	91.7	88	579.1	102.
49	343.7	60.6	09	402.8	71.0	69	461.9	81.5	29	521.0	91.9	89	580.0	102.
50	344.7	60.8	10	403.8	71.2	70	462.9	81.6	30	521.9	92.0	90	581.0	102.
351	345.7	61.0	411	404.8	71.4	471	463.8	81.8	531	522.9	92.2	591	582.0	102.
52	346.7	61.1	12	405.7	71.6	72	464.8	82.0	32	523.9	92.4	92	583.0	102.
53	347.6	61.3	13	406.7	71.7	73	465.8	82.1	33	524.9	92.5	93	584.0	102.
54	348.6	61.5	14	407.7	71.9	74	466.8	82.3	34	525.9	92.7	94	585.0	103.
55	349.6	61.7	15	408.7	72.1	75	467.8	82.5	35	526.9	92.9	95	586.0	103.
56	350.6	61.8	16	409.7	72.2	76	468.8	82.7	36	527.9	93.1	96	586.9	103.
57	351.6	62.0	17	410.7	72.4	77	469.8	82.8	37	528.8	93.2	97	587.9	103.
58	352.6	62.2	18	411.7	72.6	78	470.7	83.0	38	529.8	93.4	98	588.9	103.
59	353.5	62 4	19	412.6	72.8	79	471.7	83.2	39	530.8	93.6	99	589.9	104.
60	354.5	62.5	20	413.6	72.9	80	472.7	83.4	40	531.8	93.8	600	590.9	104.
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

80° (100°, 260°, 280°).

TABLE 2.

Difference of Latitude and Departure for 11° (169°, 191°, 349°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	1.0	0.2	61	59.9	11.6	121	118.8	23.1	181	177.7	34.5	241	236.6	46.0
2	2.0	0.4	62	60.9	11.8	22	119.8	23.3	82	178.7	34.7	42	237.6	46.2
3	2.9	0.6	63	61.8	12.0	23	120.7	23.5	83	179.6	34.9	43	238.5	46.4
4	3.9	0.8	64	62.8	12.2	24	121.7	23.7	84	180.6	35.1	44	239.5	46.6
5	4.9	1.0	65	63.8	12.4	25	122.7	23.9	85	181.6	35.3	45	240.5	46.7
6	5.9	1.1	66	64.8	12.6	26	123.7	24.0	86	182.6	35.5	46	241.5	46.9
7	6.9	1.3	67	65.8	12.8	27	124.7	24.2	87	183.6	35.7	47	242.5	47.1
8	7.9	1.5	68	66.8	13.0	28	125.6	24.4	88	184.5	35.9	48	243.4	47.3
9	8.8	1.7	69	67.7	13.2	29	126.6	24.6	89	185.5	36.1	49	244.4	47.5
10	9.8	1.9	70	68.7	13.4	30	127.6	24.8	90	186.5	36.3	50	245.4	47.7
11	10.8	2.1	71	69.7	13.5	131	128.6	25.0	191	187.5	36.4	251	246.4	47.9
12	11.8	2.3	72	70.7	13.7	32	129.6	25.2	92	188.5	36.6	52	247.4	48.1
13	12.8	2.5	73	71.7	13.9	33	130.6	25.4	93	189.5	36.8	53	248.4	48.3
14	13.7	2.7	74	72.6	14.1	34	131.5	25.6	94	190.4	37.0	54	249.3	48.5
15	14.7	2.9	75	73.6	14.3	35	132.5	25.8	95	191.4	37.2	55	250.3	48.7
16	15.7	3.1	76	74.6	14.5	36	133.5	26.0	96	192.4	37.4	56	251.3	48.8
17	16.7	3.2	77	75.6	14.7	37	134.5	26.1	97	193.4	37.6	57	252.3	49.0
18	17.7	3.4	78	76.6	14.9	38	135.5	26.3	98	194.4	37.8	58	253.3	49.2
19	18.7	3.6	79	77.5	15.1	39	136.4	26.5	99	195.3	38.0	59	254.2	49.4
20	19.6	3.8	80	78.5	15.3	40	137.4	26.7	200	196.3	38.2	60	255.2	49.6
21	20.6	4.0	81	79.5	15.5	141	138.4	26.9	201	197.3	38.4	261	256.2	49.8
22	21.6	4.2	82	80.5	15.6	42	139.4	27.1	02	198.3	38.5	62	257.2	50.0
23	22.6	4.4	83	81.5	15.8	43	140.4	27.3	03	199.3	38.7	63	258.2	50.2
24	23.6	4.6	84	82.5	16.0	44	141.4	27.5	04	200.3	38.9	64	259.1	50.4
25	24.5	4.8	85	83.4	16.2	45	142.3	27.7	05	201.2	39.1	65	260.1	50.6
26	25.5	5.0	86	84.4	16.4	46	143.3	27.9	06	202.2	39.3	66	261.1	50.8
27	26.5	5.2	87	85.4	16.6	47	144.3	28.0	07	203.2	39.5	67	262.1	50.9
28	27.5	5.3	88	86.4	16.8	48	145.3	28.2	08	204.2	39.7	68	263.1	51.1
29	28.5	5.5	89	87.4	17.0	49	146.3	28.4	09	205.2	39.9	69	264.1	51.3
30	29.4	5.7	90	88.3	17.2	50	147.2	28.6	10	206.1	40.1	70	265.0	51.5
31	30.4	5.9	91	89.3	17.4	151	148.2	28.8	211	207.1	40.3	271	266.0	51.7
32	31.4	6.1	92	90.3	17.6	52	149.2	29.0	12	208.1	40.5	72	267.0	51.9
33	32.4	6.3	93	91.3	17.7	53	150.2	29.2	13	209.1	40.6	73	268.0	52.1
34	33.4	6.5	94	92.3	17.9	54	151.2	29.4	14	210.1	40.8	74	269.0	52.3
35	34.4	6.7	95	93.3	18.1	55	152.2	29.6	15	211.0	41.0	75	269.9	52.5
36	35.3	6.9	96	94.2	18.3	56	153.1	29.8	16	212.0	41.2	76	270.9	52.7
37	36.3	7.1	97	95.2	18.5	57	154.1	30.0	17	213.0	41.4	77	271.9	52.9
38	37.3	7.3	98	96.2	18.7	58	155.1	30.1	18	214.0	41.6	78	272.9	53.0
39	38.3	7.4	99	97.2	18.9	59	156.1	30.3	19	215.0	41.8	79	273.9	53.2
40	39.3	7.6	100	98.2	19.1	60	157.1	30.5	20	216.0	42.0	80	274.9	53.4
41	40.2	7.8	101	99.1	19.3	161	158.0	30.7	221	216.9	42.2	281	275.8	53.6
42	41.2	8.0	02	100.1	19.5	62	159.0	30.9	22	217.9	42.4	82	276.8	53.8
43	42.2	8.2	03	101.1	19.7	63	160.0	31.1	23	218.9	42.6	83	277.8	54.0
44	43.2	8.4	04	102.1	19.8	64	161.0	31.3	24	219.9	42.7	84	278.8	54.2
45	44.2	8.6	05	103.1	20.0	65	162.0	31.5	25	220.9	42.9	85	279.8	54.4
46	45.2	8.8	06	104.1	20.2	66	163.0	31.7	26	221.8	43.1	86	280.7	54.6
47	46.1	9.0	07	105.0	20.4	67	163.9	31.9	27	222.8	43.3	87	281.7	54.8
48	47.1	9.2	08	106.0	20.6	68	164.9	32.1	28	223.8	43.5	88	282.7	55.0
49	48.1	9.3	09	107.0	20.8	69	165.9	32.2	29	224.8	43.7	89	283.7	55.1
50	49.1	9.5	10	108.0	21.0	70	166.9	32.4	30	225.8	43.9	90	284.7	55.3
51	50.1	9.7	111	109.0	21.2	171	167.9	32.6	231	226.8	44.1	291	285.7	55.5
52	51.0	9.9	12	109.9	21.4	72	168.8	32.8	32	227.7	44.3	92	286.6	55.7
53	52.0	10.1	13	110.9	21.6	73	169.8	33.0	33	228.7	44.5	93	287.6	55.9
54	53.0	10.3	14	111.9	21.8	74	170.8	33.2	34	229.7	44.6	94	288.6	56.1
55	54.0	10.5	15	112.9	21.9	75	171.8	33.4	35	230.7	44.8	95	289.6	56.3
56	55.0	10.7	16	113.9	22.1	76	172.8	33.6	36	231.7	45.0	96	290.6	56.5
57	56.0	10.9	17	114.9	22.3	77	173.7	33.8	37	232.6	45.2	97	291.5	56.7
58	56.9	11.1	18	115.8	22.5	78	174.7	34.0	38	233.6	45.4	98	292.5	56.9
59	57.9	11.3	19	116.8	22.7	79	175.7	34.2	39	234.6	45.6	99	293.5	57.1
60	58.9	11.4	20	117.8	22.9	80	176.7	34.3	40	235.6	45.8	300	294.5	57.2
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

79° (101°, 259°, 281°).

TABLE 2.

Difference of Latitude and Departure for 11° (169°, 191°, 349°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	295.4	57.4	361	354.3	68.9	421	413.2	80.3	481	472.1	91.8	541	531.0	103.2
02	296.4	57.6	62	355.3	69.1	22	414.2	80.5	82	473.1	92.0	42	532.0	103.4
03	297.4	57.8	63	356.3	69.3	23	415.2	80.7	83	474.1	92.2	43	533.0	103.6
04	298.4	58.0	64	357.3	69.5	24	416.2	80.9	84	475.1	92.4	44	534.0	103.8
05	299.4	58.2	65	358.3	69.6	25	417.2	81.1	85	476.1	92.6	45	535.0	104.0
06	300.3	58.4	66	359.2	69.8	26	418.1	81.3	86	477.0	92.8	46	535.9	104.2
07	301.3	58.6	67	360.2	70.0	27	419.1	81.5	87	478.0	93.0	47	536.9	104.4
08	302.3	58.8	68	361.2	70.2	28	420.1	81.7	88	479.0	93.2	48	537.9	104.6
09	303.3	59.0	69	362.2	70.4	29	421.1	81.9	89	480.0	93.3	49	538.9	104.8
10	304.3	59.2	70	363.2	70.6	30	422.1	82.1	90	481.0	93.5	50	539.9	105.0
311	305.3	59.3	371	364.1	70.8	431	423.0	82.2	491	481.9	93.6	551	540.8	105.1
12	306.2	59.5	72	365.1	71.0	32	424.0	82.4	92	482.9	93.8	52	541.8	105.3
13	307.2	59.7	73	366.1	71.2	33	425.0	82.6	93	483.9	94.0	53	542.8	105.5
14	308.2	59.9	74	367.1	71.4	34	426.0	82.8	94	484.9	94.2	54	543.8	105.7
15	309.2	60.1	75	368.1	71.6	35	427.0	83.0	95	485.9	94.4	55	544.8	105.9
16	310.2	60.3	76	369.1	71.7	36	428.0	83.2	96	486.9	94.6	56	545.8	106.1
17	311.1	60.5	77	370.0	71.9	37	428.9	83.4	97	487.8	94.8	57	546.7	106.3
18	312.1	60.7	78	371.0	72.1	38	429.9	83.6	98	488.8	95.0	58	547.7	106.5
19	313.1	60.9	79	372.0	72.3	39	430.9	83.8	99	489.8	95.2	59	548.7	106.7
20	314.1	61.1	80	373.0	72.5	40	431.9	84.0	500	490.8	95.4	60	549.7	106.9
321	315.1	61.3	381	374.0	72.7	441	432.9	84.1	501	491.8	95.6	561	550.7	107.1
22	316.1	61.4	82	374.9	72.9	42	433.8	84.3	02	492.7	95.8	62	551.6	107.2
23	317.0	61.6	83	375.9	73.1	43	434.8	84.5	03	493.7	96.0	63	552.6	107.4
24	318.0	61.8	84	376.9	73.3	44	435.8	84.7	04	494.7	96.2	64	553.6	107.6
25	319.0	62.0	85	377.9	73.5	45	436.8	84.9	05	495.7	96.4	65	554.6	107.8
26	320.0	62.2	86	378.9	73.7	46	437.8	85.1	06	496.7	96.6	66	555.6	108.0
27	321.0	62.4	87	379.9	73.8	47	438.8	85.3	07	497.7	96.8	67	556.6	108.2
28	321.9	62.6	88	380.8	74.0	48	439.7	85.5	08	498.6	97.0	68	557.6	108.4
29	322.9	62.8	89	381.8	74.2	49	440.7	85.7	09	499.6	97.2	69	558.6	108.6
30	323.9	63.0	90	382.8	74.4	50	441.7	85.9	10	500.6	97.3	70	559.5	108.8
331	324.9	63.2	391	383.8	74.6	451	442.7	86.1	511	501.6	97.5	571	560.5	109.0
32	325.9	63.4	92	384.8	74.8	52	443.7	86.2	12	502.6	97.6	72	561.5	109.1
33	326.8	63.5	93	385.7	75.0	53	444.6	86.4	13	503.5	97.8	73	562.5	109.3
34	327.8	63.7	94	386.7	75.2	54	445.6	86.6	14	504.5	98.0	74	563.5	109.5
35	328.8	63.9	95	387.7	75.4	55	446.6	86.8	15	505.5	98.2	75	564.5	109.7
36	329.8	64.1	96	388.7	75.6	56	447.6	87.0	16	506.5	98.4	76	565.4	109.9
37	330.8	64.3	97	389.7	75.8	57	448.6	87.2	17	507.5	98.6	77	566.4	110.1
38	331.8	64.5	98	390.7	75.9	58	449.6	87.4	18	508.5	98.8	78	567.4	110.3
39	332.7	64.7	99	391.6	76.1	59	450.5	87.6	19	509.4	99.0	79	568.3	110.5
40	333.7	64.9	400	392.6	76.3	60	451.5	87.8	20	510.4	99.2	80	569.3	110.7
341	334.7	65.1	401	393.6	76.5	461	452.5	88.0	521	511.4	99.4	581	570.3	110.9
42	335.7	65.3	02	394.6	76.7	62	453.5	88.2	22	512.4	99.6	82	571.3	111.1
43	336.7	65.5	03	395.6	76.9	63	454.5	88.3	23	513.4	99.8	83	572.3	111.3
44	337.6	65.6	04	396.5	77.1	64	455.4	88.5	24	514.3	100.0	84	573.2	111.5
45	338.6	65.8	05	397.5	77.3	65	456.4	88.7	25	515.3	100.2	85	574.2	111.7
46	339.6	66.0	06	398.5	77.5	66	457.4	88.9	26	516.3	100.4	86	575.2	111.8
47	340.6	66.2	07	399.5	77.7	67	458.4	89.1	27	517.3	100.6	87	576.2	112.1
48	341.6	66.4	08	400.5	77.9	68	459.4	89.3	28	518.3	100.8	88	577,2	112.3
49	342.6	66.6	09	401.5	78.1	69	460.4	89.5	29	519.3	101.0	89	578.2	112.4
50	343.5	66.8	10	402.4	78.2	70	461.3	89.7	30	520.2	101.2	90	579.1	112.6
351	344.5	67.0	411	403.4	78.4	471	462.3	89.9	531	521.2	101.4	591	580.1	112.8
52	345.5	67.2	12	404.4	78.6	72	463.3	90.1	32	522.2	101.6	92	581.1	113.0
53	346.5	67.4	13	405.4	78.8	73	464.3	90.3	33	523.2	101.7	93	582.1	113.2
54	347.5	67.5	14	406.4	79.0	74	465.3	90.4	34	524.2	101.8	94	583.1	113.3
55	348.4	67.7	15	407.3	79.2	75	466.2	90.6	35	525.1	102.0	95	584.0	113.5
56	349.4	67.9	16	408.3	79.4	76	467.2	90.8	36	526.1	102.2	96	585.0	113.7
57	350.4	68.1	17	409.3	79.6	77	468.2	91.0	37	527.1	102.4	97	586.0	113.9
58	351.4	68.3	18	410.3	79.8	78	469.2	91.2	38	528.1	102.6	98	587.0	114.1
59	352.4	68.5	19	411.3	80.0	79	470.2	91.4	39	529.1	102.8	99	588.0	114.3
60	353.4	68.7	20	412.3	80.1	80	471.1	91.6	40	530.1	103.0	600	589.0	114.5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

79° (101°, 259°, 281°).

TABLE 2.

Difference of Latitude and Departure for 12° (168°, 192°, 348°).

Dist.	Lat.	Dep	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	1.0	0.2	61	59.7	12.7	121	118.4	25.2	181	177.0	37.6	241	235.7	50.1
2	2.0	0.4	62	60.6	12.9	22	119.3	25.4	82	178.0	37.8	42	236.7	50.3
3	2.9	0.6	63	61.6	13.1	23	120.3	25.6	83	179.0	38.0	43	237.7	50.5
4	3.9	0.8	64	62.6	13.3	24	121.3	25.8	84	180.0	38.3	44	238.7	50.7
5	4.9	1.0	65	63.6	13.5	25	122.3	26.0	85	181.0	38.5	45	239.6	50.9
6	5.9	1.2	66	64.6	13.7	26	123.2	26.2	86	181.9	38.7	46	240.6	51.1
7	6.8	1.5	67	65.5	13.9	27	124.2	26.4	87	182.9	38.9	47	241.6	51.4
8	7.8	1.7	68	66.5	14.1	28	125.2	26.6	88	183.9	39.1	48	242.6	51.6
9	8.8	1.9	69	67.5	14.3	29	126.2	26.8	89	184.9	39.3	49	243.6	51.8
10	9.8	2.1	70	68.5	14.6	30	127.2	27.0	90	185.8	39.5	50	244.5	52.0
11	10.8	2.3	71	69.4	14.8	131	128.1	27.2	191	186.8	39.7	251	245.5	52.2
12	11.7	2.5	72	70.4	15.0	32	129.1	27.4	92	187.8	39.9	52	246.5	52.4
13	12.7	2.7	73	71.4	15.2	33	130.1	27.7	93	188.8	40.1	53	247.5	52.6
14	13.7	2.9	74	72.4	15.4	34	131.1	27.9	94	189.8	40.3	54	248.4	52.8
15	14.7	3.1	75	73.4	15.6	35	132.0	28.1	95	190.7	40.5	55	249.4	53.0
16	15.7	3.3	76	74.3	15.8	36	133.0	28.3	96	191.7	40.8	56	250.4	53.2
17	16.6	3.5	77	75.3	16.0	37	134.0	28.5	97	192.7	41.0	57	251.4	53.4
18	17.6	3.7	78	76.3	16.2	38	135.0	28.7	98	193.7	41.2	58	252.4	53.6
19	18.6	4.0	79	77.3	16.4	39	136.0	28.9	99	194.7	41.4	59	253.3	53.8
20	19.6	4.2	80	78.3	16.6	40	136.9	29.1	200	195.6	41.6	60	254.3	54.1
21	20.5	4.4	81	79.2	16.8	141	137.9	29.3	201	196.6	41.8	261	255.3	54.3
22	21.5	4.6	82	80.2	17.0	42	138.9	29.5	02	197.6	42.0	62	256.3	54.5
23	22.5	4.8	83	81.2	17.3	43	139.9	29.7	03	198.6	42.2	63	257.3	54.7
24	23.5	5.0	84	82.2	17.5	44	140.9	29.9	04	199.5	42.4	64	258.2	54.9
25	24.5	5.2	85	83.1	17.7	45	141.8	30.1	05	200.5	42.6	65	259.2	55.1
26	25.4	5.4	86	84.1	17.9	46	142.8	30.4	06	201.5	42.8	66	260.2	55.3
27	26.4	5.6	87	85.1	18.1	47	143.8	30.6	07	202.5	43.0	67	261.2	55.5
28	27.4	5.8	88	86.1	18.3	48	144.8	30.8	08	203.5	43.2	68	262.1	55.7
29	28.4	6.0	89	87.1	18.5	49	145.7	31.0	09	204.4	43.5	69	263.1	55.9
30	29.3	6.2	90	88.0	18.7	50	146.7	31.2	10	205.4	43.7	70	264.1	56.1
31	30.3	6.4	91	89.0	18.9	151	147.7	31.4	211	206.4	43.9	271	265.1	56.3
32	31.3	6.7	92	90.0	19.1	52	148.7	31.6	12	207.4	44.1	72	266.1	56.6
33	32.3	6.9	93	91.0	19.3	53	149.7	31.8	13	208.3	44.3	73	267.0	56.8
34	33.3	7.1	94	91.9	19.5	54	150.6	32.0	14	209.3	44.5	74	268.0	57.0
35	34.2	7.3	95	92.9	19.8	55	151.6	32.2	15	210.3	44.7	75	269.0	57.2
36	35.2	7.5	96	93.9	20.0	56	152.6	32.4	16	211.3	44.9	76	270.0	57.4
37	36.2	7.7	97	94.9	20.2	57	153.6	32.6	17	212.3	45.1	77	270.9	57.6
38	37.2	7.9	98	95.9	20.4	58	154.5	32.9	18	213.2	45.3	78	271.9	57.8
39	38.1	8.1	99	96.8	20.6	59	155.5	33.1	19	214.2	45.5	79	272.9	58.0
40	39.1	8.3	100	97.8	20.8	60	156.5	33.3	20	215.2	45.7	80	273.9	58.2
41	40.1	8.5	101	98.8	21.0	161	157.5	33.5	221	216.2	45.9	281	274.9	58.4
42	41.1	8.7	02	99.8	21.2	62	158.5	33.7	22	217.1	46.2	82	275.8	58.6
43	42.1	8.9	03	100.7	21.4	63	159.4	33.9	23	218.1	46.4	83	276.8	58.8
44	43.0	9.1	04	101.7	21.6	64	160.4	34.1	24	219.1	46.6	84	277.8	59.0
45	44.0	9.4	05	102.7	21.8	65	161.4	34.3	25	220.1	46.8	85	278.8	59.3
46	45.0	9.6	06	103.7	22.0	66	162.4	34.5	26	221.1	47.0	86	279.8	59.5
47	46.0	9.8	07	104.7	22.2	67	163.4	34.7	27	222.0	47.2	87	280.7	59.7
48	47.0	10.0	08	105.7	22.5	68	164.3	34.9	28	223.0	47.4	88	281.7	59.9
49	47.9	10.2	09	106.6	22.7	69	165.3	35.1	29	224.0	47.6	89	282.7	60.1
50	48.9	10.4	10	107.6	22.9	70	166.3	35.3	30	225.0	47.8	90	283.7	60.3
51	49.9	10.6	111	108.6	23.1	171	167.3	35.6	231	226.0	48.0	291	284.6	60.5
52	50.9	10.8	12	109.6	23.3	72	168.2	35.8	32	226.9	48.2	92	285.6	60.7
53	51.8	11.0	13	110.5	23.5	73	169.2	36.0	33	227.9	48.4	93	286.6	60.9
54	52.8	11.2	14	111.5	23.7	74	170.2	36.2	34	228.9	48.7	94	287.6	61.1
55	53.8	11.4	15	112.5	23.9	75	171.2	36.4	35	229.9	48.9	95	288.6	61.3
56	54.8	11.6	16	113.5	24.1	76	172.2	36.6	36	230.8	49.1	96	289.5	61.5
57	55.8	11.9	17	114.4	24.3	77	173.1	36.8	37	231.8	49.3	97	290.5	61.7
58	56.7	12.1	18	115.4	24.5	78	174.1	37.0	38	232.8	49.5	98	291.5	62.0
59	57.7	12.3	19	116.4	24.7	79	175.1	37.2	39	233.8	49.7	99	292.5	62.2
60	58.7	12.5	20	117.4	24.9	80	176.1	37.4	40	234.8	49.9	300	293.4	62.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

78° (102°, 258°, 282°).

TABLE 2.

Difference of Latitude and Departure for 12° (168°, 192°, 348°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	294.4	62.6	361	353.1	75.0	421	411.8	87.5	481	470.5	100.0	541	529.2	112.5
02	295.4	62.8	62	354.1	75.2	22	412.8	87.7	82	471.5	100.2	42	530.2	112.7
03	296.4	63.0	63	355.1	75.4	23	413.8	87.9	83	472.5	100.4	43	531.1	112.9
04	297.4	63.2	64	356.0	75.7	24	414.7	88.1	84	473.4	100.6	44	532.1	113.1
05	298.3	63.4	65	357.0	75.9	25	415.7	88.3	85	474.4	100.8	45	533.1	113.3
06	299.3	63.6	66	358.0	76.1	26	416.7	88.6	86	475.4	101.0	46	534.1	113.5
07	300.3	63.8	67	359.0	76.3	27	417.7	88.8	87	476.4	101.2	47	535.1	113.7
08	301.3	64.0	68	360.0	76.5	28	418.6	89.0	88	477.3	101.4	48	536.0	113.9
09	302.2	64.2	69	360.9	76.7	29	419.6	89.2	89	478.3	101.6	49	537.0	114.1
10	303.2	64.4	70	361.9	76.9	30	420.6	89.4	90	479.3	101.9	50	538.0	114.4
311	304.2	64.6	371	362.9	77.1	431	421.6	89.6	491	480.3	102.1	551	538.9	114.6
12	305.2	64.8	72	363.9	77.3	32	422.6	89.8	92	481.2	102.3	52	539.9	114.8
13	306.2	65.1	73	364.8	77.5	33	423.5	90.0	93	482.2	102.5	53	540.9	115.0
14	307.1	65.3	74	365.8	77.7	34	424.5	90.2	94	483.2	102.7	54	541.9	115.2
15	308.1	65.5	75	366.8	77.9	35	425.5	90.4	95	484.2	102.9	55	542.9	115.4
16	309.1	65.7	76	367.8	78.2	36	426.5	90.6	96	485.2	103.1	56	543.8	115.6
17	310.1	65.9	77	368.8	78.4	37	427.5	90.8	97	486.1	103.3	57	544.8	115.8
18	311.1	66.1	78	369.7	78.6	38	428.4	91.0	98	487.1	103.5	58	545.8	116.0
19	312.0	66.3	79	370.7	78.8	39	429.4	91.3	99	488.1	103.8	59	546.8	116.2
20	313.0	66.5	80	371.7	79.0	40	430.4	91.5	500	489.1	104.0	60	547.8	116.4
321	314.0	66.7	381	372.7	79.2	441	431.4	91.7	501	490.0	104.2	561	548.7	116.6
22	315.0	66.9	82	373.7	79.4	42	432.3	91.9	02	491.0	104.4	62	549.7	116.8
23	315.9	67.1	83	374.6	79.6	43	433.3	92.1	03	492.0	104.6	63	550.7	117.0
24	316.9	67.3	84	375.6	79.8	44	434.3	92.3	04	493.0	104.8	64	551.7	117.2
25	317.9	67.6	85	376.6	80.0	45	435.3	92.5	05	494.0	105.0	65	552.7	117.4
26	318.9	67.8	86	377.6	80.2	46	436.3	92.7	06	495.0	105.2	66	553.7	117.6
27	319.9	68.0	87	378.5	80.4	47	437.2	92.9	07	495.9	105.4	67	554.6	117.8
28	320.8	68.2	88	379.5	80.7	48	438.2	93.1	08	496.9	105.6	68	555.6	118.0
29	321.8	68.4	89	380.5	80.9	49	439.2	93.3	09	497.9	105.8	69	556.6	118.2
30	322.8	68.6	90	381.5	81.1	50	440.2	93.5	10	498.9	106.0	70	557.5	118.5
331	323.8	68.8	391	382.5	81.3	451	441.1	93.7	511	499.8	106.2	571	558.5	118.7
32	324.7	69.0	92	383.4	81.5	52	442.1	93.9	12	500.8	106.4	72	559.5	118.9
33	325.7	69.2	93	384.4	81.7	53	443.1	94.1	13	501.8	106.6	73	560.5	119.1
34	326.7	69.4	94	385.4	81.9	54	444.1	94.4	14	502.8	106.8	74	561.5	119.3
35	327.7	69.6	95	386.4	82.1	55	445.1	94.6	15	503.7	107.0	75	562.4	119.5
36	328.7	69.8	96	387.3	82.3	56	446.0	94.8	16	504.7	107.2	76	563.4	119.7
37	329.6	70.0	97	388.3	82.5	57	447.0	95.0	17	505.7	107.4	77	564.4	119.9
38	330.6	70.3	98	389.3	82.7	58	448.0	95.2	18	506.7	107.6	78	565.4	120.1
39	331.6	70.5	99	390.3	82.9	59	449.0	95.4	19	507.7	107.8	79	566.4	120.3
40	332.6	70.7	400	391.3	83.1	60	450.0	95.6	20	508.7	108.1	80	567.4	120.6
341	333.5	70.9	401	392.2	83.4	461	450.9	95.8	521	509.6	108.3	581	568.3	120.8
42	334.5	71.1	02	393.2	83.6	62	451.9	96.0	22	510.6	108.5	82	569.3	121.0
43	335.5	71.3	03	394.2	83.8	63	452.9	96.2	23	511.6	108.7	83	570.3	121.2
44	336.5	71.5	04	395.2	84.0	64	453.9	96.5	24	512.5	108.9	84	571.2	121.4
45	337.5	71.7	05	396.2	84.2	65	454.8	96.7	25	513.5	109.2	85	572.2	121.6
46	338.4	71.9	06	397.1	84.4	66	455.8	96.9	26	514.5	109.4	86	573.2	121.8
47	339.4	72.1	07	398.1	84.6	67	456.8	97.1	27	515.5	109.6	87	574.2	122.0
48	340.4	72.3	08	399.1	84.8	68	457.8	97.3	28	516.5	109.8	88	575.2	122.2
49	341.4	72.5	09	400.1	85.0	69	458.8	97.5	29	517.5	110.0	89	576.2	122.4
50	342.4	72.7	10	401.0	85.2	70	459.7	97.7	30	518.4	110.2	90	577.1	122.6
351	343.3	73.0	411	402.0	85.4	471	460.7	97.9	531	519.4	110.4	591	578.1	122.8
52	344.3	73.2	12	403.0	85.6	72	461.7	98.1	32	520.4	110.6	92	579.1	123.0
53	345.3	73.4	13	404.0	85.8	73	462.7	98.3	33	521.3	110.8	93	580.0	123.2
54	346.3	73.6	14	405.0	86.1	74	463.6	98.5	34	522.3	111.0	94	581.0	123.4
55	347.2	73.8	15	405.9	86.3	75	464.6	98.7	35	523.3	111.2	95	582.0	123.6
56	348.2	74.0	16	406.9	86.5	76	465.6	98.9	36	524.3	111.4	96	583.0	123.9
57	349.2	74.2	17	407.9	86.7	77	466.6	99.1	37	525.3	111.6	97	584.0	124.1
58	350.2	74.4	18	408.9	86.9	78	467.6	99.4	38	526.2	111.8	98	584.9	124.3
59	351.2	74.6	19	409.8	87.1	79	468.5	99.6	39	527.2	112.0	99	585.9	124.5
60	352.1	74.8	20	410.8	87.3	80	469.5	99.8	40	528.2	112.3	600	586.9	124.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

78° (102°, 258°, 282°).

TABLE 2.

Difference of Latitude and Departure for 13° (167°, 193°, 347°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	1.0	0.2	61	59.4	13.7	121	117.9	27.2	181	176.4	40.7	241	234.8	54.2
2	1.9	0.4	62	60.4	13.9	22	118.9	27.4	82	177.3	40.9	42	235.8	54.4
3	2.9	0.7	63	61.4	14.2	23	119.8	27.7	83	178.3	41.2	43	236.8	54.7
4	3.9	0.9	64	62.4	14.4	24	120.8	27.9	84	179.3	41.4	44	237.7	54.9
5	4.9	1.1	65	63.3	14.6	25	121.8	28.1	85	180.3	41.6	45	238.7	55.1
6	5.8	1.3	66	64.3	14.8	26	122.8	28.3	86	181.2	41.8	46	239.7	55.3
7	6.8	1.6	67	65.3	15.1	27	123.7	28.6	87	182.2	42.1	47	240.7	55.6
8	7.8	1.8	68	66.3	15.3	28	124.7	28.8	88	183.2	42.3	48	241.6	55.8
9	8.8	2.0	69	67.2	15.5	29	125.7	29.0	89	184.2	42.5	49	242.6	56.0
10	9.7	2.2	70	68.2	15.7	30	126.7	29.2	90	185.1	42.7	50	243.6	56.2
11	10.7	2.5	71	69.2	16.0	131	127.6	29.5	191	186.1	43.0	251	244.6	56.5
12	11.7	2.7	72	70.2	16.2	32	128.6	29.7	92	187.1	43.2	52	245.5	56.7
13	12.7	2.9	73	71.1	16.4	33	129.6	29.9	93	188.1	43.4	53	246.5	56.9
14	13.6	3.1	74	72.1	16.6	34	130.6	30.1	94	189.0	43.6	54	247.5	57.1
15	14.6	3.4	75	73.1	16.9	35	131.5	30.4	95	190.0	43.9	55	248.5	57.4
16	15.6	3.6	76	74.1	17.1	36	132.5	30.6	96	191.0	44.1	56	249.4	57.6
17	16.6	3.8	77	75.0	17.3	37	133.5	30.8	97	192.0	44.3	57	250.4	57.8
18	17.5	4.0	78	76.0	17.5	38	134.5	31.0	98	192.9	44.5	58	251.4	58.0
19	18.5	4.3	79	77.0	17.8	39	135.4	31.3	99	193.9	44.8	59	252.4	58.3
20	19.5	4.5	80	77.9	18.0	40	136.4	31.5	200	194.9	45.0	60	253.3	58.5
21	20.5	4.7	81	78.9	18.2	141	137.4	31.7	201	195.8	45.2	261	254.3	58.7
22	21.4	4.9	82	79.9	18.4	42	138.4	31.9	02	196.8	45.4	62	255.3	58.9
23	22.4	5.2	83	80.9	18.7	43	139.3	32.2	03	197.8	45.7	63	256.3	59.2
24	23.4	5.4	84	81.8	18.9	44	140.3	32.4	04	198.8	45.9	64	257.2	59.4
25	24.4	5.6	85	82.8	19.1	45	141.3	32.6	05	199.7	46.1	65	258.2	59.6
26	25.3	5.8	86	83.8	19.3	46	142.3	32.8	06	200.7	46.3	66	259.2	59.8
27	26.3	6.1	87	84.8	19.6	47	143.2	33.1	07	201.7	46.6	67	260.2	60.1
28	27.3	6.3	88	85.7	19.8	48	144.2	33.3	08	202.7	46.8	68	261.1	60.3
29	28.3	6.5	89	86.7	20.0	49	145.2	33.5	09	203.6	47.0	69	262.1	60.5
30	29.2	6.7	90	87.7	20.2	50	146.2	33.7	10	204.6	47.2	70	263.1	60.7
31	30.2	7.0	91	88.7	20.5	151	147.1	34.0	211	205.6	47.5	271	264.1	61.0
32	31.2	7.2	92	89.6	20.7	52	148.1	34.2	12	206.6	47.7	72	265.0	61.2
33	32.2	7.4	93	90.6	20.9	53	149.1	34.4	13	207.5	47.9	73	266.0	61.4
34	33.1	7.6	94	91.6	21.1	54	150.1	34.6	14	208.5	48.1	74	267.0	61.6
35	34.1	7.9	95	92.6	21.4	55	151.0	34.9	15	209.5	48.4	75	268.0	61.9
36	35.1	8.1	96	93.5	21.6	56	152.0	35.1	16	210.5	48.6	76	268.9	62.1
37	36.1	8.3	97	94.5	21.8	57	153.0	35.3	17	211.4	48.8	77	269.9	62.3
38	37.0	8.5	98	95.5	22.0	58	154.0	35.5	18	212.4	49.0	78	270.9	62.5
39	38.0	8.8	99	96.5	22.3	59	154.9	35.8	19	213.4	49.3	79	271.8	62.8
40	39.0	9.0	100	97.4	22.5	60	155.9	36.0	20	214.4	49.5	80	272.8	63.0
41	39.9	9.2	101	98.4	22.7	161	156.9	36.2	221	215.3	49.7	281	273.8	63.2
42	40.9	9.4	02	99.4	22.9	62	157.8	36.4	22	216.3	49.9	82	274.8	63.4
43	41.9	9.7	03	100.4	23.2	63	158.8	36.7	23	217.3	50.2	83	275.7	63.7
44	42.9	9.9	04	101.3	23.4	64	159.8	36.9	24	218.3	50.4	84	276.7	63.9
45	43.8	10.1	05	102.3	23.6	65	160.8	37.1	25	219.2	50.6	85	277.7	64.1
46	44.8	10.3	06	103.3	23.8	66	161.7	37.3	26	220.2	50.8	86	278.7	64.3
47	45.8	10.6	07	104.3	24.1	67	162.7	37.6	27	221.2	51.1	87	279.6	64.6
48	46.8	10.8	08	105.2	24.3	68	163.7	37.8	28	222.2	51.3	88	280.6	64.8
49	47.7	11.0	09	106.2	24.5	69	164.7	38.0	29	223.1	51.5	89	281.6	65.0
50	48.7	11.2	10	107.2	24.7	70	165.6	38.2	30	224.1	51.7	90	282.6	65.2
51	49.7	11.5	111	108.2	25.0	171	166.6	38.5	231	225.1	52.0	291	283.5	65.5
52	50.7	11.7	12	109.1	25.2	72	167.6	38.7	32	226.1	52.2	92	284.5	65.7
53	51.6	11.9	13	110.1	25.4	73	168.6	38.9	33	227.0	52.4	93	285.5	65.9
54	52.6	12.1	14	111.1	25.6	74	169.5	39.1	34	228.0	52.6	94	286.5	66.1
55	53.6	12.4	15	112.1	25.9	75	170.5	39.4	35	229.0	52.9	95	287.4	66.4
56	54.6	12.6	16	113.0	26.1	76	171.5	39.6	36	230.0	53.1	96	288.4	66.6
57	55.5	12.8	17	114.0	26.3	77	172.5	39.8	37	230.9	53.3	97	289.4	66.8
58	56.5	13.0	18	115.0	26.5	78	173.4	40.0	38	231.9	53.5	98	290.4	67.0
59	57.5	13.3	19	116.0	26.8	79	174.4	40.3	39	232.9	53.8	99	291.3	67.3
60	58.5	13.5	20	116.9	27.0	80	175.4	40.5	40	233.8	54.0	300	292.3	67.5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

77° (103°, 257°, 283°).

TABLE 2.

Difference of Latitude and Departure for 13° (167°, 193°, 347°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	293.3	67.7	361	351.8	81.2	421	410.2	94.7	481	468.7	108.2	541	527.2	121.7
02	294.3	67.9	62	352.7	81.4	22	411.2	94.9	82	469.7	108.4	42	528.1	121.9
03	295.2	68.1	63	353.7	81.6	23	412.2	95.1	83	470.6	108.6	43	529.1	122.1
04	296.2	68.4	64	354.7	81.9	24	413.1	95.3	84	471.6	108.8	44	530.1	122.3
05	297.2	68.6	65	355.6	82.1	25	414.1	95.6	85	472.6	109.0	45	531.1	122.5
06	298.2	68.8	66	356.6	82.3	26	415.1	95.8	86	473.6	109.3	46	532.0	122.8
07	299.1	69.0	67	357.6	82.5	27	416.1	96.0	87	474.5	109.5	47	533.0	123.0
08	300.1	69.3	68	358.6	82.8	28	417.0	96.2	88	475.5	109.7	48	534.0	123.2
09	301.1	69.5	69	359.5	83.0	29	418.0	96.5	89	476.5	109.9	49	535.0	123.4
10	302.1	69.7	70	360.5	83.2	30	419.0	96.7	90	477.5	110.1	50	535.9	123.7
311	303.0	69.9	371	361.5	83.4	431	420.0	96.9	491	478.4	110.4	551	536.9	123.9
12	304.0	70.2	72	362.5	83.7	32	420.9	97.1	92	479.4	110.6	52	537.9	124.1
13	305.0	70.4	73	363.4	83.9	33	421.9	97.4	93	480.4	110.9	53	538.9	124.4
14	306.0	70.6	74	364.4	84.1	34	422.9	97.6	94	481.4	111.1	54	539.8	124.6
15	306.9	70.8	75	365.4	84.3	35	423.9	97.8	95	482.3	111.3	55	540.8	124.9
16	307.9	71.1	76	366.4	84.6	36	424.8	98.0	96	483.3	111.5	56	541.8	125.1
17	308.9	71.3	77	367.3	84.8	37	425.8	98.3	97	484.3	111.8	57	542.8	125.3
18	309.9	71.5	78	368.3	85.0	38	426.8	98.5	98	485.3	112.0	58	543.7	125.5
19	310.8	71.7	79	369.3	85.2	39	427.8	98.7	99	486.2	112.2	59	544.7	125.8
20	311.8	72.0	80	370.3	85.5	40	428.7	98.9	500	487.2	112.4	60	545.7	126.0
321	312.8	72.2	381	371.2	85.7	441	429.7	99.2	501	488.2	112.6	561	546.7	126.2
22	313.8	72.4	82	372.2	85.9	42	430.7	99.4	02	489.2	112.9	62	547.6	126.4
23	314.7	72.6	83	373.2	86.1	43	431.6	99.6	03	490.1	113.1	63	548.6	126.7
24	315.7	72.9	84	374.2	86.4	44	432.6	99.8	04	491.1	113.3	64	549.6	126.9
25	316.7	73.1	85	375.1	86.6	45	433.6	100.1	05	492.1	113.5	65	550.6	127.1
26	317.6	73.3	86	376.1	86.8	46	434.6	100.3	06	493.1	113.8	66	551.5	127.3
27	318.6	73.5	87	377.1	87.0	47	435.5	100.5	07	494.0	114.0	67	552.5	127.6
28	319.6	73.8	88	378.1	87.3	48	436.5	100.7	08	495.0	114.2	68	553.5	127.8
29	320.6	74.0	89	379.0	87.5	49	437.5	101.0	09	496.0	114.5	69	554.5	128.0
30	321.5	74.2	90	380.0	87.7	50	438.5	101.2	10	496.9	114.7	70	555.4	128.3
331	322.5	74.4	391	381.0	87.9	451	439.4	101.4	511	497.9	114.9	571	556.4	128.5
32	323.5	74.7	92	382.0	88.2	52	440.4	101.6	12	498.9	115.1	72	557.4	128.7
33	324.5	74.9	93	382.9	88.4	53	441.4	101.9	13	499.9	115.4	73	558.4	128.9
34	325.4	75.1	94	383.9	88.6	54	442.4	102.1	14	500.8	115.6	74	559.3	129.2
35	326.4	75.3	95	384.9	88.8	55	443.3	102.3	15	501.8	115.8	75	560.3	129.4
36	327.4	75.6	96	385.9	89.1	56	444.3	102.5	16	502.8	116.0	76	561.3	129.6
37	328.4	75.8	97	386.8	89.3	57	445.3	102.8	17	503.8	116.3	77	562.3	129.8
38	329.3	76.0	98	387.8	89.5	58	446.3	103.0	18	504.7	116.5	78	563.2	130.0
39	330.3	76.2	99	388.8	89.7	59	447.2	103.2	19	505.7	116.7	79	564.2	130.2
40	331.3	76.5	400	389.8	90.0	60	448.2	103.4	20	506.7	116.9	80	565.2	130.4
341	332.3	76.7	401	390.7	90.2	461	449.2	103.7	521	507.7	117.2	581	566.2	130.7
42	333.2	76.9	02	391.7	90.4	62	450.2	103.9	22	508.6	117.5	82	567.1	131.0
43	334.2	77.1	03	392.7	90.6	63	451.1	104.1	23	509.6	117.7	83	568.1	131.2
44	335.2	77.4	04	393.6	90.8	64	452.1	104.3	24	510.6	117.9	84	569.1	131.4
45	336.2	77.6	05	394.6	91.1	65	453.1	104.6	25	511.6	118.1	85	570.1	131.6
46	337.1	77.8	06	395.6	91.3	66	454.1	104.8	26	512.5	118.3	86	571.0	131.8
47	338.1	78.0	07	396.6	91.5	67	455.0	105.0	27	513.5	118.5	87	572.0	132.0
48	339.1	78.3	08	397.5	91.7	68	456.0	105.2	28	514.5	118.7	88	573.0	132.3
49	340.1	78.5	09	398.5	92.0	69	457.0	105.5	29	515.5	119.0	89	573.9	132.5
50	341.0	78.7	10	399.5	92.2	70	458.0	105.7	30	516.4	119.2	90	574.9	132.8
351	342.0	78.9	411	400.5	92.4	471	458.9	105.9	531	517.4	119.4	591	575.9	133.0
52	343.0	79.2	12	401.4	92.6	72	459.9	106.1	32	518.4	119.6	92	576.9	133.2
53	344.0	79.4	13	402.4	92.9	73	460.9	106.4	33	519.4	119.9	93	577.8	133.4
54	344.9	79.6	14	403.4	93.1	74	461.9	106.6	34	520.3	120.1	94	578.8	133.6
55	345.9	79.8	15	404.4	93.3	75	462.8	106.8	35	521.3	120.3	95	579.8	133.8
56	346.9	80.1	16	405.3	93.5	76	463.8	107.0	36	522.3	120.5	96	580.8	134.0
57	347.9	80.3	17	406.3	93.8	77	464.8	107.3	37	523.3	120.8	97	581.7	134.3
58	348.8	80.5	18	407.3	94.0	78	465.8	107.5	38	524.2	121.0	98	582.7	134.5
59	349.8	80.7	19	408.3	94.2	79	466.7	107.7	39	525.2	121.2	99	583.7	134.8
60	350.8	81.0	20	409.2	94.4	80	467.7	107.9	40	526.2	121.5	600	584.6	135.0
Dist.	Dep.	Lat.	Dist	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

77° (103°, 257°, 283°).

TABLE 2.

Difference of Latitude and Departure for 14° (166°, 194°, 346°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	1.0	0.2	61	59.2	14.8	121	117.4	29.3	181	175.6	43.8	241	233.8	58.3
2	1.9	0.5	62	60.2	15.0	22	118.4	29.5	82	176.6	44.0	42	234.8	58.5
3	2.9	0.7	63	61.1	15.2	23	119.3	29.8	83	177.6	44.3	43	235.8	58.8
4	3.9	1.0	64	62.1	15.5	24	120.3	30.0	84	178.5	44.5	44	236.8	59.0
5	4.9	1.2	65	63.1	15.7	25	121.3	30.2	85	179.5	44.8	45	237.7	59.3
6	5.8	1.5	66	64.0	16.0	26	122.3	30.5	86	180.5	45.0	46	238.7	59.5
7	6.8	1.7	67	65.0	16.2	27	123.2	30.7	87	181.4	45.2	47	239.7	59.8
8	7.8	1.9	68	66.0	16.5	28	124.2	31.0	88	182.4	45.5	48	240.6	60.0
9	8.7	2.2	69	67.0	16.7	29	125.2	31.2	89	183.4	45.7	49	241.6	60.2
10	9.7	2.4	70	67.9	16.9	30	126.1	31.4	90	184.4	46.0	50	242.6	60.5
11	10.7	2.7	71	68.9	17.2	131	127.1	31.7	191	185.3	46.2	251	243.5	60.7
12	11.6	2.9	72	69.9	17.4	32	128.1	31.9	92	186.3	46.4	52	244.5	61.0
13	12.6	3.1	73	70.8	17.7	33	129.0	32.2	93	187.3	46.7	53	245.5	61.2
14	13.6	3.4	74	71.8	17.9	34	130.0	32.4	94	188.2	46.9	54	246.5	61.4
15	14.6	3.6	75	72.8	18.1	35	131.0	32.7	95	189.2	47.2	55	247.4	61.7
16	15.5	3.9	76	73.7	18.4	36	132.0	32.9	96	190.2	47.4	56	248.4	61.9
17	16.5	4.1	77	74.7	18.6	37	132.9	33.1	97	191.1	47.7	57	249.4	62.2
18	17.5	4.4	78	75.7	18.9	38	133.9	33.4	98	192.1	47.9	58	250.3	62.4
19	18.4	4.6	79	76.7	19.1	39	134.9	33.6	99	193.1	48.1	59	251.3	62.7
20	19.4	4.8	80	77.6	19.4	40	135.8	33.9	200	194.1	48.4	60	252.3	62.9
21	20.4	5.1	81	78.6	19.6	141	136.8	34.1	201	195.0	48.6	261	253.2	63.1
22	21.3	5.3	82	79.6	19.8	42	137.8	34.4	02	196.0	48.9	62	254.2	63.4
23	22.3	5.6	83	80.5	20.1	43	138.8	34.6	03	197.0	49.1	63	255.2	63.6
24	23.3	5.8	84	81.5	20.3	44	139.7	34.8	04	197.9	49.4	64	256.2	63.9
25	24.3	6.0	85	82.5	20.6	45	140.7	35.1	05	198.9	49.6	65	257.1	64.1
26	25.2	6.3	86	83.4	20.8	46	141.7	35.3	06	199.9	49.8	66	258.1	64.4
27	26.2	6.5	87	84.4	21.0	47	142.6	35.6	07	200.9	50.1	67	259.1	64.6
28	27.2	6.8	88	85.4	21.3	48	143.6	35.8	08	201.8	50.3	68	260.0	64.8
29	28.1	7.0	89	86.4	21.5	49	144.6	36.0	09	202.8	50.6	69	261.0	65.1
30	29.1	7.3	90	87.3	21.8	50	145.5	36.3	10	203.8	50.8	70	262.0	65.3
31	30.1	7.5	91	88.3	22.0	151	146.5	36.5	211	204.7	51.0	271	263.0	65.6
32	31.0	7.7	92	89.3	22.3	52	147.5	36.8	12	205.7	51.3	72	263.9	65.8
33	32.0	8.0	93	90.2	22.5	53	148.5	37.0	13	206.7	51.5	73	264.9	66.0
34	33.0	8.2	94	91.2	22.7	54	149.4	37.3	14	207.6	51.8	74	265.9	66.3
35	34.0	8.5	95	92.2	23.0	55	150.4	37.5	15	208.6	52.0	75	266.8	66.5
36	34.9	8.7	96	93.1	23.2	56	151.4	37.7	16	209.6	52.3	76	267.8	66.8
37	35.9	9.0	97	94.1	23.5	57	152.3	38.0	17	210.6	52.5	77	268.8	67.0
38	36.9	9.2	98	95.1	23.7	58	153.3	38.2	18	211.5	52.7	78	269.7	67.3
39	37.8	9.4	99	96.1	24.0	59	154.3	38.5	19	212.5	53.0	79	270.7	67.5
40	38.8	9.7	100	97.0	24.2	60	155.2	38.7	20	213.5	53.2	80	271.7	67.7
41	39.8	9.9	101	98.0	24.4	161	156.2	38.9	221	214.4	53.5	281	272.7	68.0
42	40.8	10.2	02	99.0	24.7	62	157.2	39.2	22	215.4	53.7	82	273.6	68.2
43	41.7	10.4	03	99.9	24.9	63	158.2	39.4	23	216.4	53.9	83	274.6	68.5
44	42.7	10.6	04	100.9	25.2	64	159.1	39.7	24	217.3	54.2	84	275.6	68.7
45	43.7	10.9	05	101.9	25.4	65	160.1	39.9	25	218.3	54.4	85	276.5	68.9
46	44.6	11.1	06	102.9	25.6	66	161.1	40.2	26	219.3	54.7	86	277.5	69.2
47	45.6	11.4	07	103.8	25.9	67	162.0	40.4	27	220.3	54.9	87	278.5	69.4
48	46.6	11.6	08	104.8	26.1	68	163.0	40.6	28	221.2	55.2	88	279.4	69.7
49	47.5	11.9	09	105.8	26.4	69	164.0	40.9	29	222.2	55.4	89	280.4	69.9
50	48.5	12.1	10	106.7	26.6	70	165.0	41.1	30	223.2	55.6	90	281.4	70.2
51	49.5	12.3	111	107.7	26.9	171	165.9	41.4	231	224.1	55.9	291	282.4	70.4
52	50.5	12.6	12	108.7	27.1	72	166.9	41.6	32	225.1	56.1	92	283.3	70.6
53	51.4	12.8	13	109.6	27.3	73	167.9	41.9	33	226.1	56.4	93	284.3	70.9
54	52.4	13.1	14	110.6	27.6	74	168.8	42.1	34	227.0	56.6	94	285.3	71.1
55	53.4	13.3	15	111.6	27.8	75	169.8	42.3	35	228.0	56.9	95	286.2	71.4
56	54.3	13.5	16	112.6	28.1	76	170.8	42.6	36	229.0	57.1	96	287.2	71.6
57	55.3	13.8	17	113.5	28.3	77	171.7	42.8	37	230.0	57.3	97	288.2	71.9
58	56.3	14.0	18	114.5	28.5	78	172.7	43.1	38	230.9	57.6	98	289.1	72.1
59	57.2	14.3	19	115.5	28.8	79	173.7	43.3	39	231.9	57.8	99	290.1	72.3
60	58.2	14.5	20	116.4	29.0	80	174.7	43.5	40	232.9	58.1	300	291.1	72.6
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

76° (104°, 256°, 284°).

TABLE 2.

Difference of Latitude and Departure for 14° (166°, 194°, 346°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	292.0	72.8	361	350.2	87.3	421	408.5	101.8	481	466.7	116.3	541	525.0	130.9
02	293.0	73.0	62	351.2	87.6	22	409.4	102.1	82	467.7	116.6	42	525.9	131.2
03	294.0	73.3	63	352.2	87.8	23	410.4	102.3	83	468.6	116.8	43	526.9	131.4
04	294.9	73.5	64	353.2	88.0	24	411.4	102.6	84	469.6	117.1	44	527.9	131.6
05	295.9	73.8	65	354.1	88.3	25	412.3	102.8	85	470.6	117.3	45	528.8	131.9
06	296.9	74.0	66	355.1	88.5	26	413.3	103.0	86	471.5	117.6	46	529.8	132.1
07	297.8	74.2	67	356.1	88.8	27	414.3	103.3	87	472.5	117.8	47	530.8	132.3
08	298.8	74.5	68	357.0	89.0	28	415.3	103.5	88	473.5	118.0	48	531.7	132.6
09	299.8	74.7	69	358.0	89.2	29	416.2	103.8	89	474.5	118.3	49	532.7	132.8
10	300.8	75.0	70	359.0	89.5	30	417.2	104.0	90	475.4	118.5	50	533.7	133.0
311	301.7	75.2	371	359.9	89.7	431	418.2	104.2	491	476.4	118.8	551	534.6	133.3
12	302.7	75.5	72	360.9	90.0	32	419.1	104.5	92	477.4	119.0	52	535.6	133.6
13	303.7	75.7	73	361.9	90.2	33	420.1	104.7	93	478.3	119.2	53	536.6	133.8
14	304.6	75.9	74	362.9	90.5	34	421.1	105.0	94	479.3	119.5	54	537.5	134.0
15	305.6	76.2	75	363.8	90.7	35	422.0	105.2	95	480.3	119.7	55	538.5	134.3
16	306.6	76.4	76	364.8	90.9	36	423.0	105.5	96	481.3	120.0	56	539.5	134.5
17	307.6	76.7	77	365.8	91.2	37	424.0	105.7	97	482.2	120.2	57	540.5	134.8
18	308.5	76.9	78	366.7	91.4	38	425.0	105.9	98	483.2	120.4	58	541.4	135.0
19	309.5	77.2	79	367.7	91.7	39	425.9	106.2	99	484.2	120.7	59	542.4	135.2
20	310.5	77.4	80	368.7	91.9	40	426.9	106.4	500	485.1	121.0	60	543.4	135.5
321	311.4	77.6	381	369.6	92.2	441	427.9	106.7	501	486.1	121.2	561	544.3	135.7
22	312.4	77.9	82	370.6	92.4	42	428.8	106.9	02	487.1	121.4	62	545.3	135.9
23	313.4	78.1	83	371.6	92.6	43	429.8	107.1	03	488.0	121.7	63	546.3	136.2
24	314.3	78.4	84	372.6	92.9	44	430.8	107.4	04	489.0	122.0	64	547.2	136.5
25	315.3	78.6	85	373.5	93.1	45	431.7	107.6	05	490.0	122.1	65	548.2	136.6
26	316.3	78.8	86	374.5	93.4	46	432.7	107.9	06	491.0	122.4	66	549.2	136.9
27	317.3	79.1	87	375.5	93.6	47	433.7	108.1	07	491.9	122.6	67	550.1	137.1
28	318.2	79.3	88	376.4	93.8	48	434.7	108.4	08	492.9	122.9	68	551.1	137.4
29	319.2	79.6	89	377.4	94.1	49	435.6	108.6	09	493.9	123.1	69	552.1	137.6
30	320.2	79.8	90	378.4	94.3	50	436.6	108.8	10	494.9	123.4	70	553.1	137.9
331	321.1	80.1	391	379.4	94.6	451	437.6	109.1	511	495.8	123.6	571	554.0	138.1
32	322.1	80.3	92	380.3	94.8	52	438.5	109.3	12	496.8	123.8	72	555.0	138.3
33	323.1	80.5	93	381.3	95.1	53	439.5	109.6	13	497.8	124.1	73	556.0	138.6
34	324.0	80.8	94	382.3	95.3	54	440.5	109.8	14	498.7	124.3	74	557.0	138.8
35	325.0	81.0	95	383.2	95.5	55	441.5	110.1	15	499.7	124.6	75	557.9	139.1
36	326.0	81.3	96	384.2	95.8	56	442.4	110.3	16	500.7	124.8	76	558.9	139.3
37	327.0	81.5	97	385.2	96.0	57	443.4	110.5	17	501.7	125.0	77	559.9	139.5
38	327.9	81.7	98	386.1	96.3	58	444.4	110.8	18	502.6	125.3	78	560.9	139.8
39	328.9	82.0	99	387.1	96.5	59	445.3	111.0	19	503.6	125.6	79	561.8	140.0
40	329.9	82.2	400	388.1	96.7	60	446.3	111.3	20	504.6	125.8	80	562.8	140.3
341	330.8	82.5	401	389.1	97.0	461	447.3	111.5	521	505.5	126.0	581	563.8	140.5
42	331.8	82.7	02	390.0	97.2	62	448.2	111.7	22	506.5	126.2	82	564.7	140.8
43	332.8	83.0	03	391.0	97.5	63	449.2	112.0	23	507.5	126.5	83	565.7	141.0
44	333.7	83.2	04	392.0	97.7	64	450.2	112.2	24	508.4	126.8	84	566.7	141.3
45	334.7	83.4	05	392.9	98.0	65	451.2	112.5	25	509.4	127.0	85	567.6	141.5
46	335.7	83.7	06	393.9	98.2	66	452.1	112.7	26	510.4	127.2	86	568.6	141.8
47	336.7	83.9	07	394.9	98.4	67	453.1	113.0	27	511.4	127.5	87	569.6	142.0
48	337.6	84.2	08	395.8	98.7	68	454.1	113.2	28	512.3	127.8	88	570.6	142.3
49	338.6	84.4	09	396.8	98.9	69	455.0	113.4	29	513.3	128.0	89	571.5	142.5
50	339.6	84.7	10	397.8	99.2	70	456.0	113.7	30	514.3	128.2	90	572.5	142.8
351	340.5	84.9	411	398.8	99.4	471	457.0	113.9	531	515.3	128.5	591	573.5	143.0
52	341.5	85.1	12	399.7	99.7	72	457.9	114.2	32	516.2	128.8	92	574.4	143.3
53	342.5	85.4	13	400.7	99.9	73	458.9	114.4	33	517.2	129.0	93	575.4	143.5
54	343.5	85.6	14	401.7	100.1	74	459.9	114.6	34	518.2	129.2	94	576.4	143.8
55	344.4	85.9	15	402.6	100.4	75	460.9	114.9	35	519.1	129.4	95	577.3	144.0
56	345.4	86.1	16	403.6	100.6	76	461.8	115.1	36	520.1	129.7	96	578.3	144.2
57	346.4	86.3	17	404.6	100.9	77	462.8	115.4	37	521.1	129.9	97	579.3	144.5
58	347.3	86.6	18	405.5	101.1	78	463.8	115.6	38	522.1	130.2	98	580.3	144.7
59	348.3	86.8	19	406.5	101.3	79	464.7	115.9	39	523.0	130.4	99	581.2	144.9
60	349.3	87.1	20	407.5	101.6	80	465.7	116.1	40	524.0	130.6	600	582.2	145.1
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

76° (104°, 256°, 284°).

TABLE 2.

Difference of Latitude and Departure for 15° (165°, 195°, 345°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	1.0	0.3	61	58.9	15.8	121	116.9	31.3	181	174.8	46.8	241	232.8	62.4
2	1.9	0.5	62	59.9	16.0	22	117.8	31.6	82	175.8	47.1	42	233.8	62.6
3	2.9	0.8	63	60.9	16.3	23	118.8	31.8	83	176.8	47.4	43	234.7	62.9
4	3.9	1.0	64	61.8	16.6	24	119.8	32.1	84	177.7	47.6	44	235.7	63.2
5	4.8	1.3	65	62.8	16.8	25	120.7	32.4	85	178.7	47.9	45	236.7	63.4
6	5.8	1.6	66	63.8	17.1	26	121.7	32.6	86	179.7	48.1	46	237.6	63.7
7	6.8	1.8	67	64.7	17.3	27	122.7	32.9	87	180.6	48.4	47	238.6	63.9
8	7.7	2.1	68	65.7	17.6	28	123.6	33.1	88	181.6	48.7	48	239.5	64.2
9	8.7	2.3	69	66.6	17.9	29	124.6	33.4	89	182.6	48.9	49	240.5	64.4
10	9.7	2.6	70	67.6	18.1	30	125.6	33.6	90	183.5	49.2	50	241.5	64.7
11	10.6	2.8	71	68.6	18.4	131	126.5	33.9	191	184.5	49.4	251	242.4	65.0
12	11.6	3.1	72	69.5	18.6	32	127.5	34.2	92	185.5	49.7	52	243.4	65.2
13	12.6	3.4	73	70.5	18.9	33	128.5	34.4	93	186.4	50.0	53	244.4	65.5
14	13.5	3.6	74	71.5	19.2	34	129.4	34.7	94	187.4	50.2	54	245.3	65.7
15	14.5	3.9	75	72.4	19.4	35	130.4	34.9	95	188.4	50.5	55	246.3	66.0
16	15.5	4.1	76	73.4	19.7	36	131.4	35.2	96	189.3	50.7	56	247.3	66.3
17	16.4	4.4	77	74.4	19.9	37	132.3	35.5	97	190.3	51.0	57	248.2	66.5
18	17.4	4.7	78	75.3	20.2	38	133.3	35.7	98	191.3	51.2	58	249.2	66.8
19	18.4	4.9	79	76.3	20.4	39	134.3	36.0	99	192.2	51.5	59	250.2	67.0
20	19.3	5.2	80	77.3	20.7	40	135.2	36.2	200	193.2	51.8	60	251.1	67.3
21	20.3	5.4	81	78.2	21.0	141	136.2	36.5	201	194.2	52.0	261	252.1	67.6
22	21.3	5.7	82	79.2	21.2	42	137.2	36.8	02	195.1	52.3	62	253.1	67.8
23	22.2	6.0	83	80.2	21.5	43	138.1	37.0	03	196.1	52.5	63	254.0	68.1
24	23.2	6.2	84	81.1	21.7	44	139.1	37.3	04	197.0	52.8	64	255.0	68.3
25	24.1	6.5	85	82.1	22.0	45	140.1	37.5	05	198.0	53.1	65	256.0	68.6
26	25.1	6.7	86	83.1	22.3	46	141.0	37.8	06	199.0	53.3	66	256.9	68.8
27	26.1	7.0	87	84.0	22.5	47	142.0	38.0	07	199.9	53.6	67	257.9	69.1
28	27.0	7.2	88	85.0	22.8	48	143.0	38.3	08	200.9	53.8	68	258.9	69.4
29	28.0	7.5	89	86.0	23.0	49	143.9	38.6	09	201.9	54.1	69	259.8	69.6
30	29.0	7.8	90	86.9	23.3	50	144.9	38.8	10	202.8	54.4	70	260.8	69.9
31	29.9	8.0	91	87.9	23.6	151	145.9	39.1	211	203.8	54.6	271	261.8	70.1
32	30.9	8.3	92	88.9	23.8	52	146.8	39.3	12	204.8	54.9	72	262.7	70.4
33	31.9	8.5	93	89.8	24.1	53	147.8	39.6	13	205.7	55.1	73	263.7	70.7
34	32.8	8.8	94	90.8	24.3	54	148.8	39.9	14	206.7	55.4	74	264.7	70.9
35	33.8	9.1	95	91.8	24.6	55	149.7	40.1	15	207.7	55.6	75	265.6	71.2
36	34.8	9.3	96	92.7	24.8	56	150.7	40.4	16	208.6	55.9	76	266.6	71.4
37	35.7	9.6	97	93.7	25.1	57	151.7	40.6	17	209.6	56.2	77	267.6	71.7
38	36.7	9.8	98	94.7	25.4	58	152.6	40.9	18	210.6	56.4	78	268.5	72.0
39	37.7	10.1	99	95.6	25.6	59	153.6	41.2	19	211.5	56.7	79	269.5	72.2
40	38.6	10.4	100	96.6	25.9	60	154.5	41.4	20	212.5	56.9	80	270.5	72.5
41	39.6	10.6	101	97.6	26.1	161	155.5	41.7	221	213.5	57.2	281	271.4	72.7
42	40.6	10.9	02	98.5	26.4	62	156.5	41.9	22	214.4	57.5	82	272.4	73.0
43	41.5	11.1	03	99.5	26.7	63	157.4	42.2	23	215.4	57.7	83	273.4	73.2
44	42.5	11.4	04	100.5	26.9	64	158.4	42.4	24	216.4	58.0	84	274.3	73.5
45	43.5	11.6	05	101.4	27.2	65	159.4	42.7	25	217.3	58.2	85	275.3	73.8
46	44.4	11.9	06	102.4	27.4	66	160.3	43.0	26	218.3	58.5	86	276.3	74.0
47	45.4	12.2	07	103.4	27.7	67	161.3	43.2	27	219.3	58.8	87	277.2	74.3
48	46.4	12.4	08	104.3	28.0	68	162.3	43.5	28	220.2	59.0	88	278.2	74.5
49	47.3	12.7	09	105.3	28.2	69	163.2	43.7	29	221.2	59.3	89	279.2	74.8
50	48.3	12.9	10	106.3	28.5	70	164.2	44.0	30	222.2	59.5	90	280.1	75.1
51	49.3	13.2	111	107.2	28.7	171	165.2	44.3	231	223.1	59.8	291	281.1	75.3
52	50.2	13.5	12	108.2	29.0	72	166.1	44.5	32	224.1	60.0	92	282.1	75.6
53	51.2	13.7	13	109.1	29.2	73	167.1	44.8	33	225.1	60.3	93	283.0	75.8
54	52.2	14.0	14	110.1	29.5	74	168.1	45.0	34	226.0	60.6	94	284.0	76.1
55	53.1	14.2	15	111.1	29.8	75	169.0	45.3	35	227.0	60.8	95	284.9	76.4
56	54.1	14.5	16	112.0	30.0	76	170.0	45.6	36	228.0	61.1	96	285.9	76.6
57	55.1	14.8	17	113.0	30.3	77	171.0	45.8	37	228.9	61.3	97	286.9	76.9
58	56.0	15.0	18	114.0	30.5	78	171.9	46.1	38	229.9	61.6	98	287.8	77.1
59	57.0	15.3	19	114.9	30.8	79	172.9	46.3	39	230.9	61.9	99	288.8	77.4
60	58.0	15.5	20	115.9	31.1	80	173.9	46.6	40	231.8	62.1	300	289.8	77.6
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

75° (105°, 255°, 285°).

TABLE 2.

Difference of Latitude and Departure for 15° (165°, 195°, 345°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	290.7	77.9	361	348.7	93.4	421	406.6	109.0	481	464.6	124.5	541	522.6	140.0
02	291.7	78.2	62	349.6	93.7	22	407.6	109.2	82	465.6	124.8	42	523.5	140.3
03	292.7	78.4	63	350.6	94.0	23	408.6	109.5	83	466.5	125.0	43	524.5	140.5
04	293.6	78.7	64	351.6	94.2	24	409.5	109.7	84	467.5	125.3	44	525.5	140.8
05	294.6	78.9	65	352.5	94.5	25	410.5	110.0	85	468.5	125.6	45	526.4	141.1
06	295.6	79.2	66	353.5	94.7	26	411.5	110.3	86	469.4	125.8	46	527.4	141.4
07	296.5	79.5	67	354.5	95.0	27	412.4	110.5	87	470.4	126.1	47	528.4	141.6
08	297.5	79.7	68	355.4	95.3	28	413.4	110.8	88	471.4	126.4	48	529.3	141.9
09	298.4	80.0	69	356.4	95.5	29	414.4	111.0	89	472.3	126.6	49	530.3	142.1
10	299.4	80.2	70	357.4	95.8	30	415.3	111.3	90	473.3	126.9	50	531.3	142.4
311	300.4	80.5	371	358.3	96.0	431	416.3	111.6	491	474.3	127.1	551	532.2	142.6
12	301.3	80.8	72	359.3	96.3	32	417.3	111.8	92	475.2	127.4	52	533.2	142.9
13	302.3	81.0	73	360.3	96.5	33	418.2	112.1	93	476.2	127.6	53	534.2	143.1
14	303.3	81.3	74	361.2	96.8	34	419.2	112.3	94	477.2	127.9	54	535.1	143.4
15	304.2	81.5	75	362.2	97.1	35	420.2	112.6	95	478.1	128.1	55	536.1	143.7
16	305.2	81.8	76	363.2	97.3	36	421.1	112.9	96	479.1	128.4	56	537.1	143.9
17	306.2	82.1	77	364.1	97.6	37	422.1	113.1	97	480.1	128.6	57	538.0	144.2
18	307.1	82.3	78	365.1	97.8	38	423.1	113.4	98	481.0	128.9	58	539.0	144.4
19	308.1	82.6	79	366.1	98.1	39	424.0	113.6	99	482.0	129.1	59	540.0	144.7
20	309.1	82.8	80	367.0	98.4	40	425.0	113.9	500	483.0	129.4	60	540.9	144.9
321	310.0	83.1	381	368.0	98.6	441	426.0	114.1	501	483.9	129.7	561	541.9	145.2
22	311.0	83.3	82	369.0	98.9	42	426.9	114.4	02	484.9	129.9	62	542.9	145.4
23	312.0	83.6	83	369.9	99.1	43	427.9	114.7	03	485.9	130.2	63	543.8	145.7
24	312.9	83.9	84	370.9	99.4	44	428.8	114.9	04	486.8	130.4	64	544.8	146.0
25	313.9	84.1	85	371.9	99.6	45	429.8	115.2	05	487.8	130.7	65	545.8	146.2
26	314.9	84.4	86	372.8	99.9	46	430.8	115.4	06	488.8	131.0	66	546.7	146.5
27	315.8	84.6	87	373.8	100.2	47	431.7	115.7	07	489.7	131.2	67	547.7	146.7
28	316.8	84.9	88	374.8	100.4	48	432.7	116.0	08	490.7	131.5	68	548.7	147.0
29	317.8	85.1	89	375.7	100.7	49	433.7	116.2	09	491.7	131.7	69	549.6	147.2
30	318.7	85.4	90	376.7	100.9	50	434.6	116.5	10	492.6	132.0	70	550.6	147.5
331	319.7	85.7	391	377.7	101.2	451	435.6	116.7	511	493.6	132.3	571	551.6	147.8
32	320.7	85.9	92	378.6	101.5	52	436.6	117.0	12	494.5	132.5	72	552.5	148.0
33	321.6	86.2	93	379.6	101.7	53	437.5	117.3	13	495.5	132.8	73	553.5	148.3
34	322.6	86.5	94	380.6	102.0	54	438.5	117.5	14	496.5	133.0	74	554.4	148.5
35	323.6	86.7	95	381.5	102.2	55	439.5	117.8	15	497.4	133.3	75	555.4	148.8
36	324.5	87.0	96	382.5	102.5	56	440.4	118.0	16	498.4	133.5	76	556.4	149.0
37	325.5	87.2	97	383.4	102.8	57	441.4	118.3	17	499.4	133.8	77	557.3	149.3
38	326.5	87.5	98	384.4	103.0	58	442.4	118.5	18	500.3	134.0	78	558.3	149.5
39	327.4	87.7	99	385.4	103.3	59	443.3	118.8	19	501.3	134.3	79	559.3	149.8
40	328.4	88.0	400	386.3	103.5	60	444.3	119.1	20	502.3	134.6	80	560.2	150.1
341	329.4	88.3	401	387.3	103.8	461	445.3	119.3	521	503.2	134.8	581	561.2	150.3
42	330.3	88.5	02	388.3	104.1	62	446.2	119.6	22	504.2	135.1	82	562.2	150.6
43	331.3	88.8	03	389.2	104.3	63	447.2	119.8	23	505.2	135.3	83	563.1	150.8
44	332.3	89.0	04	390.2	104.6	64	448.2	120.1	24	506.1	135.6	84	564.1	151.1
45	333.2	89.3	05	391.2	104.8	65	449.1	120.4	25	507.1	135.9	85	565.1	151.4
46	334.2	89.6	06	392.1	105.1	66	450.1	120.6	26	508.1	136.1	86	566.0	151.6
47	335.2	89.8	07	393.1	105.3	67	451.1	120.9	27	509.0	136.4	87	567.0	151.9
48	336.1	90.1	08	394.1	105.6	68	452.0	121.1	28	510.0	136.6	88	568.0	152.2
49	337.1	90.3	09	395.0	105.9	69	453.0	121.4	29	511.0	136.9	89	568.9	152.4
50	338.1	90.6	10	396.0	106.1	70	454.0	121.7	30	511.9	137.2	90	569.9	152.7
351	339.0	90.9	411	397.0	106.4	471	454.9	121.9	531	512.9	137.4	591	570.9	153.0
52	340.0	91.1	12	397.9	106.6	72	455.9	122.2	32	513.9	137.7	92	571.8	153.2
53	340.9	91.4	13	398.9	106.9	73	456.9	122.4	33	514.8	137.9	93	572.8	153.5
54	341.9	91.6	14	399.9	107.2	74	457.8	122.7	34	515.8	138.2	94	573.8	153.7
55	342.9	91.9	15	400.8	107.4	75	458.8	122.9	35	516.8	138.4	95	574.7	154.0
56	343.8	92.1	16	401.8	107.7	76	459.8	123.2	36	517.7	138.7	96	575.7	154.2
57	344.8	92.4	17	402.8	107.9	77	460.7	123.5	37	518.7	139.0	97	576.7	154.5
58	345.8	92.7	18	403.7	108.2	78	461.7	123.7	38	519.7	139.2	98	577.6	154.8
59	346.7	92.9	19	404.7	108.5	79	462.7	124.0	39	520.6	139.5	99	578.6	155.0
60	347.7	93.2	20	405.7	108.7	80	463.6	124.2	40	521.6	139.7	600	579.5	155.3
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

75° (105°, 255°, 285°).

TABLE 2.

Difference of Latitude and Departure for 16° (164°, 196°, 344°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	1.0	0.3	61	58.6	16.8	121	116.3	33.4	181	174.0	49.9	241	231.7	66.4
2	1.9	0.6	62	59.6	17.1	22	117.3	33.6	82	174.9	50.2	42	232.6	66.7
3	2.9	0.8	63	60.6	17.4	23	118.2	33.9	83	175.9	50.4	43	233.6	67.0
4	3.8	1.1	64	61.5	17.6	24	119.2	34.2	84	176.9	50.7	44	234.5	67.3
5	4.8	1.4	65	62.5	17.9	25	120.2	34.5	85	177.8	51.0	45	235.5	67.5
6	5.8	1.7	66	63.4	18.2	26	121.1	34.7	86	178.8	51.3	46	236.5	67.8
7	6.7	1.9	67	64.4	18.5	27	122.1	35.0	87	179.8	51.5	47	237.4	68.1
8	7.7	2.2	68	65.4	18.7	28	123.0	35.3	88	180.7	51.8	48	238.4	68.4
9	8.7	2.5	69	66.3	19.0	29	124.0	35.6	89	181.7	52.1	49	239.4	68.6
10	9.6	2.8	70	67.3	19.3	30	125.0	35.8	90	182.6	52.4	50	240.3	68.9
11	10.6	3.0	71	68.2	19.6	131	125.9	36.1	191	183.6	52.6	251	241.3	69.2
12	11.5	3.3	72	69.2	19.8	32	126.9	36.4	92	184.6	52.9	52	242.2	69.5
13	12.5	3.6	73	70.2	20.1	33	127.8	36.7	93	185.5	53.2	53	243.2	69.7
14	13.5	3.9	74	71.1	20.4	34	128.8	36.9	94	186.5	53.5	54	244.2	70.0
15	14.4	4.1	75	72.1	20.7	35	129.8	37.2	95	187.4	53.7	55	245.1	70.3
16	15.4	4.4	76	73.1	20.9	36	130.7	37.5	96	188.4	54.0	56	246.1	70.6
17	16.3	4.7	77	74.0	21.2	37	131.7	37.8	97	189.4	54.3	57	247.0	70.8
18	17.3	5.0	78	75.0	21.5	38	132.7	38.0	98	190.3	54.6	58	248.0	71.1
19	18.3	5.2	79	75.9	21.8	39	133.6	38.3	99	191.3	54.9	59	249.0	71.4
20	19.2	5.5	80	76.9	22.1	40	134.6	38.6	200	192.3	55.1	60	249.9	71.7
21	20.2	5.8	81	77.9	22.3	141	135.5	38.9	201	193.2	55.4	261	250.9	71.9
22	21.1	6.1	82	78.8	22.6	42	136.5	39.1	02	194.2	55.7	62	251.9	72.2
23	22.1	6.3	83	79.8	22.9	43	137.5	39.4	03	195.1	56.0	63	252.8	72.5
24	23.1	6.6	84	80.7	23.2	44	138.4	39.7	04	196.1	56.2	64	253.8	72.8
25	24.0	6.9	85	81.7	23.4	45	139.4	40.0	05	197.1	56.5	65	254.7	73.0
26	25.0	7.2	86	82.7	23.7	46	140.3	40.2	06	198.0	56.8	66	255.7	73.3
27	26.0	7.4	87	83.6	24.0	47	141.3	40.5	07	199.0	57.1	67	256.7	73.6
28	26.9	7.7	88	84.6	24.3	48	142.3	40.8	08	199.9	57.3	68	257.6	73.9
29	27.9	8.0	89	85.6	24.5	49	143.2	41.1	09	200.9	57.6	69	258.6	74.1
30	28.8	8.3	90	86.5	24.8	50	144.2	41.3	10	201.9	57.9	70	259.5	74.4
31	29.8	8.5	91	87.5	25.1	151	145.2	41.6	211	202.8	58.2	271	260.5	74.7
32	30.8	8.8	92	88.4	25.4	52	146.1	41.9	12	203.8	58.4	72	261.5	75.0
33	31.7	9.1	93	89.4	25.6	53	147.1	42.2	13	204.7	58.7	73	262.4	75.2
34	32.7	9.4	94	90.4	25.9	54	148.0	42.4	14	205.7	59.0	74	263.4	75.5
35	33.6	9.6	95	91.3	26.2	55	149.0	42.7	15	206.7	59.3	75	264.3	75.8
36	34.6	9.9	96	92.3	26.5	56	150.0	43.0	16	207.6	59.5	76	265.3	76.1
37	35.6	10.2	97	93.2	26.7	57	150.9	43.3	17	208.6	59.8	77	266.3	76.4
38	36.5	10.5	98	94.2	27.0	58	151.9	43.6	18	209.6	60.1	78	267.2	76.6
39	37.5	10.7	99	95.2	27.3	59	152.8	43.8	19	210.5	60.4	79	268.2	76.9
40	38.5	11.0	100	96.1	27.6	60	153.8	44.1	20	211.5	60.6	80	269.2	77.2
41	39.4	11.3	101	97.1	27.8	161	154.8	44.4	221	212.4	60.9	281	270.1	77.5
42	40.4	11.6	02	98.0	28.1	62	155.7	44.7	22	213.4	61.2	82	271.1	77.7
43	41.3	11.9	03	99.0	28.4	63	156.7	44.9	23	214.4	61.5	83	272.0	78.0
44	42.3	12.1	04	100.0	28.7	64	157.6	45.2	24	215.3	61.7	84	273.0	78.3
45	43.3	12.4	05	100.9	28.9	65	158.6	45.5	25	216.3	62.0	85	274.0	78.6
46	44.2	12.7	06	101.9	29.2	66	159.6	45.8	26	217.2	62.3	86	274.9	78.8
47	45.2	13.0	07	102.9	29.5	67	160.5	46.0	27	218.2	62.6	87	275.9	79.1
48	46.1	13.2	08	103.8	29.8	68	161.5	46.3	28	219.2	62.8	88	276.8	79.4
49	47.1	13.5	09	104.8	30.0	69	162.5	46.6	29	220.1	63.1	89	277.8	79.7
50	48.1	13.8	10	105.7	30.3	70	163.4	46.9	30	221.1	63.4	90	278.8	79.9
51	49.0	14.1	111	106.7	30.6	171	164.4	47.1	231	222.1	63.7	291	279.7	80.2
52	50.0	14.3	12	107.7	30.9	72	165.3	47.4	32	223.0	63.9	92	280.7	80.5
53	50.9	14.6	13	108.6	31.1	73	166.3	47.7	33	224.0	64.2	93	281.6	80.8
54	51.9	14.9	14	109.6	31.4	74	167.3	48.0	34	224.9	64.5	94	282.6	81.0
55	52.9	15.2	15	110.5	31.7	75	168.2	48.2	35	225.9	64.8	95	283.6	81.3
56	53.8	15.4	16	111.5	32.0	76	169.2	48.5	36	226.9	65.1	96	284.5	81.6
57	54.8	15.7	17	112.5	32.2	77	170.1	48.8	37	227.8	65.3	97	285.5	81.9
58	55.8	16.0	18	113.4	32.5	78	171.1	49.1	38	228.8	65.6	98	286.5	82.1
59	56.7	16.3	19	114.4	32.8	79	172.1	49.3	39	229.7	65.9	99	287.4	82.4
60	57.7	16.5	20	115.4	33.1	80	173.0	49.6	40	230.7	66.2	300	288.4	82.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

74° (106°, 254°, 286°).

TABLE 2.

Difference of Latitude and Departure for 16° (164°, 196°, 344°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	289.3	82.9	361	347.0	99.5	421	404.7	116.0	481	462.4	132.5	541	520.1	149.1
02	290.3	83.2	62	348.0	99.7	22	405.6	116.3	82	463.3	132.8	42	521.0	149.4
03	291.2	83.5	63	348.9	100.0	23	406.6	116.6	83	464.3	133.1	43	522.0	149.7
04	292.2	83.8	64	349.9	100.3	24	407.6	116.8	84	465.2	133.4	44	523.0	150.0
05	293.2	84.0	65	350.8	100.6	25	408.5	117.1	85	466.2	133.6	45	523.9	150.2
06	294.1	84.3	66	351.8	100.8	26	409.5	117.4	86	467.2	133.9	46	524.9	150.4
07	295.1	84.6	67	352.8	101.1	27	410.4	117.7	87	468.1	134.2	47	525.9	150.7
08	296.0	84.9	68	353.7	101.4	28	411.4	117.9	88	469.1	134.5	48	526.8	151.0
09	297.0	85.1	69	354.7	101.7	29	412.4	118.2	89	470.1	134.8	49	527.8	151.3
10	298.0	85.4	70	355.6	101.9	30	413.3	118.5	90	471.0	135.0	50	528.7	151.6
311	298.9	85.7	371	356.6	102.2	431	414.3	118.8	491	472.0	135.3	551	529.7	151.9
12	299.9	86.0	72	357.6	102.5	32	415.2	119.0	92	472.9	135.6	52	530.6	152.2
13	300.9	86.2	73	358.5	102.8	33	416.2	119.3	93	473.9	135.9	53	531.6	152.5
14	301.8	86.5	74	359.5	103.1	34	417.2	119.6	94	474.9	136.2	54	532.6	152.8
15	302.8	86.8	75	360.4	103.3	35	418.1	119.9	95	475.8	136.4	55	533.5	153.0
16	303.7	87.1	76	361.4	103.6	36	419.1	120.1	96	476.8	136.7	56	534.5	153.2
17	304.7	87.3	77	362.4	103.9	37	420.0	120.4	97	477.7	137.0	57	535.4	153.5
18	305.7	87.6	78	363.3	104.2	38	421.0	120.7	98	478.7	137.3	58	536.4	153.8
19	306.6	87.9	79	364.3	104.4	39	422.0	121.0	99	479.7	137.5	59	537.4	154.1
20	307.6	88.2	80	365.3	104.7	40	422.9	121.2	500	480.6	137.8	60	538.3	154.4
321	308.5	88.4	381	366.2	105.0	441	423.9	121.5	501	481.6	138.1	561	539.3	154.7
22	309.5	88.7	82	367.2	105.3	42	424.9	121.8	02	482.6	138.3	62	540.3	154.9
23	310.5	89.0	83	368.1	105.5	43	425.8	122.1	03	483.5	138.6	63	541.2	155.2
24	311.4	89.3	84	369.1	105.8	44	426.8	122.3	04	484.5	138.9	64	542.2	155.4
25	312.4	89.5	85	370.1	106.1	45	427.7	122.6	05	485.4	139.2	65	543.1	155.7
26	313.3	89.8	86	371.0	106.4	46	428.7	122.9	06	486.4	139.4	66	544.1	156.0
27	314.3	90.1	87	372.0	106.6	47	429.7	123.2	07	487.3	139.7	67	545.1	156.3
28	315.3	90.4	88	372.9	106.9	48	430.6	123.4	08	488.3	140.0	68	546.0	156.6
29	316.2	90.6	89	373.9	107.2	49	431.6	123.7	09	489.3	140.3	69	547.0	156.9
30	317.2	90.9	90	374.9	107.5	50	432.6	124.0	10	490.2	140.6	70	547.9	157.1
331	318.2	91.2	391	375.8	107.7	451	433.5	124.3	511	491.2	140.8	571	548.9	157.3
32	319.1	91.5	92	376.8	108.0	52	434.5	124.6	12	492.1	141.1	72	549.8	157.6
33	320.1	91.8	93	377.8	108.3	53	435.4	124.8	13	493.1	141.4	73	550.8	157.9
34	321.0	92.0	94	378.7	108.6	54	436.4	125.1	14	494.1	141.7	74	551.8	158.2
35	322.0	92.3	95	379.7	108.8	55	437.4	125.4	15	495.0	141.9	75	552.7	158.4
36	323.0	92.6	96	380.6	109.1	56	438.3	125.7	16	496.0	142.2	76	553.7	158.7
37	323.9	92.9	97	381.6	109.4	57	439.3	125.9	17	496.9	142.5	77	554.6	159.0
38	324.9	93.1	98	382.6	109.7	58	440.2	126.2	18	497.9	142.8	78	555.6	159.3
39	325.8	93.4	99	383.5	109.9	59	441.2	126.5	19	498.9	143.0	79	556.5	159.5
40	326.8	93.7	400	384.5	110.2	60	442.2	126.8	20	499.8	143.3	80	557.5	159.8
341	327.8	94.0	401	385.4	110.5	461	443.1	127.0	521	500.8	143.6	581	558.4	160.1
42	328.7	94.2	02	386.4	110.8	62	444.1	127.3	22	501.7	143.9	82	559.4	160.4
43	329.7	94.5	03	387.4	111.0	63	445.0	127.6	23	502.7	144.1	83	560.4	160.6
44	330.7	94.8	04	388.3	111.3	64	446.0	127.9	24	503.7	144.4	84	561.3	161.0
45	331.6	95.1	05	389.3	111.6	65	447.0	128.1	25	504.6	144.7	85	562.3	161.3
46	332.6	95.3	06	390.2	111.9	66	447.9	128.4	26	505.6	145.0	86	563.2	161.6
47	333.5	95.6	07	391.2	112.1	67	448.9	128.7	27	506.6	145.3	87	564.2	161.8
48	334.5	95.9	08	392.2	112.4	68	449.8	129.0	28	507.5	145.6	88	565.2	162.1
49	335.5	96.2	09	393.1	112.7	69	450.8	129.2	29	508.5	145.8	89	566.1	162.4
50	336.4	96.4	10	394.1	113.0	70	451.8	129.5	30	509.4	146.1	90	567.1	162.7
351	337.4	96.7	411	395.1	113.3	471	452.7	129.8	531	510.4	146.4	591	568.1	162.9
52	338.3	97.0	12	396.0	113.5	72	453.7	130.1	32	511.4	146.7	92	569.0	163.2
53	339.3	97.3	13	397.0	113.8	73	454.7	130.3	33	512.3	146.9	93	570.0	163.5
54	340.3	97.5	14	397.9	114.1	74	455.6	130.6	34	513.3	147.2	94	571.0	163.8
55	341.2	97.8	15	398.9	114.4	75	456.6	130.9	35	514.3	147.5	95	571.9	164.0
56	342.2	98.1	16	399.9	114.6	76	457.5	131.2	36	515.2	147.8	96	572.9	164.3
57	343.1	98.4	17	400.8	114.9	77	458.5	131.4	37	516.2	148.0	97	573.9	164.6
58	344.1	98.6	18	401.8	115.2	78	459.5	131.7	38	517.2	148.2	98	574.8	164.9
59	345.1	98.9	19	402.7	115.5	79	460.4	132.0	39	518.1	148.5	99	575.8	165.1
60	346.0	99.2	20	403.7	115.8	80	461.4	132.3	40	519.1	148.8	600	576.8	165.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

74° (106°, 254°, 286°).

TABLE 2.

Difference of Latitude and Departure for 17° (163°, 197°, 343°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	1.0	0.3	61	58.3	17.8	121	115.7	35.4	181	173.1	52.9	241	230.5	70.5
2	1.9	0.6	62	59.3	18.1	22	116.7	35.7	82	174.0	53.2	42	231.4	70.8
3	2.9	0.9	63	60.2	18.4	23	117.6	36.0	83	175.0	53.5	43	232.4	71.0
4	3.8	1.2	64	61.2	18.7	24	118.6	36.3	84	176.0	53.8	44	233.3	71.3
5	4.8	1.5	65	62.2	19.0	25	119.5	36.5	85	176.9	54.1	45	234.3	71.6
6	5.7	1.8	66	63.1	19.3	26	120.5	36.8	86	177.9	54.4	46	235.3	71.9
7	6.7	2.0	67	64.1	19.6	27	121.5	37.1	87	178.8	54.7	47	236.2	72.2
8	7.7	2.3	68	65.0	19.9	28	122.4	37.4	88	179.8	55.0	48	237.2	72.5
9	8.6	2.6	69	66.0	20.2	29	123.4	37.7	89	180.7	55.3	49	238.1	72.8
10	9.6	2.9	70	66.9	20.5	30	124.3	38.0	90	181.7	55.6	50	239.1	73.1
11	10.5	3.2	71	67.9	20.8	131	125.3	38.3	191	182.7	55.8	251	240.0	73.4
12	11.5	3.5	72	68.9	21.1	32	126.2	38.6	92	183.6	56.1	52	241.0	73.7
13	12.4	3.8	73	69.8	21.3	33	127.2	38.9	93	184.6	56.4	53	241.9	74.0
14	13.4	4.1	74	70.8	21.6	34	128.1	39.2	94	185.5	56.7	54	242.9	74.3
15	14.3	4.4	75	71.7	21.9	35	129.1	39.5	95	186.5	57.0	55	243.9	74.6
16	15.3	4.7	76	72.7	22.2	36	130.1	39.8	96	187.4	57.3	56	244.8	74.8
17	16.3	5.0	77	73.6	22.5	37	131.0	40.1	97	188.4	57.6	57	245.8	75.1
18	17.2	5.3	78	74.6	22.8	38	132.0	40.3	98	189.3	57.9	58	246.7	75.4
19	18.2	5.6	79	75.5	23.1	39	132.9	40.6	99	190.3	58.2	59	247.7	75.7
20	19.1	5.8	80	76.5	23.4	40	133.9	40.9	200	191.3	58.5	60	248.6	76.0
21	20.1	6.1	81	77.5	23.7	141	134.8	41.2	201	192.2	58.8	261	249.6	76.3
22	21.0	6.4	82	78.4	24.0	42	135.8	41.5	02	193.2	59.1	62	250.6	76.6
23	22.0	6.7	83	79.4	24.3	43	136.8	41.8	03	194.1	59.4	63	251.5	76.9
24	23.0	7.0	84	80.3	24.6	44	137.7	42.1	04	195.1	59.6	64	252.5	77.2
25	23.9	7.3	85	81.3	24.9	45	138.7	42.4	05	196.0	59.9	65	253.4	77.5
26	24.9	7.6	86	82.2	25.1	46	139.6	42.7	06	197.0	60.2	66	254.4	77.8
27	25.8	7.9	87	83.2	25.4	47	140.6	43.0	07	198.0	60.5	67	255.3	78.1
28	26.8	8.2	88	84.2	25.7	48	141.5	43.3	08	198.9	60.8	68	256.3	78.4
29	27.7	8.5	89	85.1	26.0	49	142.5	43.6	09	199.9	61.1	69	257.2	78.6
30	28.7	8.8	90	86.1	26.3	50	143.4	43.9	10	200.8	61.4	70	258.2	78.9
31	29.6	9.1	91	87.0	26.6	151	144.4	44.1	211	201.8	61.7	271	259.2	79.2
32	30.6	9.4	92	88.0	26.9	52	145.4	44.4	12	202.7	62.0	72	260.1	79.5
33	31.6	9.6	93	88.9	27.2	53	146.3	44.7	13	203.7	62.3	73	261.1	79.8
34	32.5	9.9	94	89.9	27.5	54	147.3	45.0	14	204.6	62.6	74	262.0	80.1
35	33.5	10.2	95	90.8	27.8	55	148.2	45.3	15	205.6	62.9	75	263.0	80.4
36	34.4	10.5	96	91.8	28.1	56	149.2	45.6	16	206.6	63.2	76	263.9	80.7
37	35.4	10.8	97	92.8	28.4	57	150.1	45.9	17	207.5	63.4	77	264.9	81.0
38	36.3	11.1	98	93.7	28.7	58	151.1	46.2	18	208.5	63.7	78	265.9	81.3
39	37.3	11.4	99	94.7	28.9	59	152.1	46.5	19	209.4	64.0	79	266.8	81.6
40	38.3	11.7	100	95.6	29.2	60	153.0	46.8	20	210.4	64.3	80	267.8	81.9
41	39.2	12.0	101	96.6	29.5	161	154.0	47.1	221	211.3	64.6	281	268.7	82.2
42	40.2	12.3	02	97.5	29.8	62	154.9	47.4	22	212.3	64.9	82	269.7	82.4
43	41.1	12.6	03	98.5	30.1	63	155.9	47.7	23	213.3	65.2	83	270.6	82.7
44	42.1	12.9	04	99.5	30.4	64	156.8	47.9	24	214.2	65.5	84	271.6	83.0
45	43.0	13.2	05	100.4	30.7	65	157.8	48.2	25	215.2	65.8	85	272.5	83.3
46	44.0	13.4	06	101.4	31.0	66	158.7	48.5	26	216.1	66.1	86	273.5	83.6
47	44.9	13.7	07	102.3	31.3	67	159.7	48.8	27	217.1	66.4	87	274.5	83.9
48	45.9	14.0	08	103.3	31.6	68	160.7	49.1	28	218.0	66.7	88	275.4	84.2
49	46.9	14.3	09	104.2	31.9	69	161.6	49.4	29	219.0	67.0	89	276.4	84.5
50	47.8	14.6	10	105.2	32.2	70	162.6	49.7	30	220.0	67.2	90	277.3	84.8
51	48.8	14.9	111	106.1	32.5	171	163.5	50.0	231	220.9	67.5	291	278.3	85.1
52	49.7	15.2	12	107.1	32.7	72	164.5	50.3	32	221.9	67.8	92	279.2	85.4
53	50.7	15.5	13	108.1	33.0	73	165.4	50.6	33	222.8	68.1	93	280.2	85.7
54	51.6	15.8	14	109.0	33.3	74	166.4	50.9	34	223.8	68.4	94	281.2	86.0
55	52.6	16.1	15	110.0	33.6	75	167.4	51.2	35	224.7	68.7	95	282.1	86.2
56	53.6	16.4	16	110.9	33.9	76	168.3	51.5	36	225.7	69.0	96	283.1	86.5
57	54.5	16.7	17	111.9	34.2	77	169.3	51.7	37	226.6	69.3	97	284.0	86.8
58	55.5	17.0	18	112.8	34.5	78	170.2	52.0	38	227.6	69.6	98	285.0	87.1
59	56.4	17.2	19	113.8	34.8	79	171.2	52.3	39	228.6	69.9	99	285.9	87.4
60	57.4	17.5	20	114.8	35.1	80	172.1	52.6	40	229.5	70.2	300	286.9	87.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

73° (107°, 253°, 287°).

TABLE 2.

Difference of Latitude and Departure for 17° (163°, 197°, 343°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	287.8	88.0	361	345.2	105.5	421	402.6	123.1	481	460.0	140.6	541	517.3	158.2
02	288.8	88.3	62	346.1	105.8	22	403.5	123.4	82	460.9	140.9	42	518.3	158.5
03	289.7	88.6	63	347.1	106.1	23	404.5	123.7	83	461.9	141.2	43	519.2	158.8
04	290.7	88.9	64	348.1	106.4	24	405.4	124.0	84	462.8	141.5	44	520.2	159.1
05	291.6	89.2	65	349.0	106.7	25	406.4	124.3	85	463.8	141.8	45	521.2	159.3
06	292.6	89.5	66	350.0	107.0	26	407.3	124.6	86	464.7	142.1	46	522.1	159.6
07	293.5	89.8	67	350.9	107.3	27	408.3	124.8	87	465.7	142.3	47	523.1	159.9
08	294.5	90.1	68	351.9	107.6	28	409.3	125.1	88	466.7	142.6	48	524.0	160.2
09	295.5	90.3	69	352.8	107.9	29	410.2	125.4	89	467.6	142.9	49	525.0	160.5
10	296.4	90.6	70	353.8	108.2	30	411.2	125.7	90	468.6	143.2	50	526.0	160.8
311	297.4	90.9	371	354.8	108.5	431	412.1	126.0	491	469.5	143.5	551	526.9	161.1
12	298.3	91.2	72	355.7	108.8	32	413.1	126.3	92	470.5	143.8	52	527.9	161.4
13	299.3	91.5	73	356.7	109.1	33	414.0	126.6	93	471.4	144.1	53	528.8	161.7
14	300.2	91.8	74	357.6	109.4	34	415.0	126.9	94	472.4	144.4	54	529.8	162.0
15	301.2	92.1	75	358.6	109.6	35	416.0	127.2	95	473.4	144.7	55	530.8	162.3
16	302.2	92.4	76	359.5	109.9	36	416.9	127.5	96	474.3	145.0	56	531.7	162.6
17	303.1	92.7	77	360.5	110.2	37	417.9	127.8	97	475.3	145.3	57	532.7	162.9
18	304.1	93.0	78	361.4	110.5	38	418.8	128.1	98	476.2	145.6	58	533.6	163.2
19	305.0	93.3	79	362.4	110.8	39	419.8	128.4	99	477.2	145.9	59	534.6	163.5
20	306.0	93.6	80	363.4	111.1	40	420.7	128.6	500	478.1	146.2	60	535.5	163.8
321	306.9	93.9	381	364.3	111.4	441	421.7	128.9	501	479.1	146.5	561	536.5	164.1
22	307.9	94.1	82	365.3	111.7	42	422.7	129.2	02	480.1	146.8	62	537.5	164.4
23	308.8	94.4	83	366.2	112.0	43	423.6	129.5	03	481.0	147.1	63	538.4	164.6
24	309.8	94.7	84	367.2	112.3	44	424.6	129.8	04	482.0	147.4	64	539.4	164.8
25	310.8	95.0	85	368.1	112.6	45	425.5	130.1	05	482.9	147.7	65	540.3	165.1
26	311.7	95.3	86	369.1	112.9	46	426.5	130.4	06	483.9	148.0	66	541.3	165.4
27	312.7	95.6	87	370.1	113.2	47	427.4	130.7	07	484.8	148.3	67	542.2	165.7
28	313.6	95.9	88	371.0	113.4	48	428.4	131.0	08	485.8	148.6	68	543.2	166.0
29	314.6	96.2	89	372.0	113.7	49	429.3	131.3	09	486.7	148.9	69	544.1	166.4
30	315.5	96.5	90	372.9	114.0	50	430.3	131.6	10	487.7	149.1	70	545.1	166.7
331	316.5	96.8	391	373.9	114.3	451	431.3	131.9	511	488.7	149.4	571	546.1	167.0
32	317.5	97.1	92	374.8	114.6	52	432.2	132.2	12	489.6	149.7	72	547.0	167.2
33	318.4	97.4	93	375.8	114.9	53	433.2	132.4	13	490.6	150.0	73	548.0	167.5
34	319.4	97.7	94	376.7	115.2	54	434.1	132.7	14	491.5	150.2	74	548.9	167.8
35	320.3	97.9	95	377.7	115.5	55	435.1	133.0	15	492.5	150.5	75	549.9	168.1
36	321.3	98.2	96	378.7	115.8	56	436.0	133.3	16	493.4	150.8	76	550.8	168.4
37	322.2	98.5	97	379.6	116.1	57	437.0	133.6	17	494.4	151.1	77	551.8	168.7
38	323.2	98.8	98	380.6	116.4	58	438.0	133.9	18	495.3	151.4	78	552.7	169.0
39	324.2	99.1	99	381.5	116.7	59	438.9	134.2	19	496.3	151.7	79	553.7	169.3
40	325.1	99.4	400	382.5	117.0	60	439.9	134.5	20	497.2	152.0	80	554.6	169.6
341	326.1	99.7	401	383.4	117.2	461	440.8	134.8	521	498.2	152.3	581	555.6	169.9
42	327.0	100.0	02	384.4	117.5	62	441.8	135.1	22	499.2	152.6	82	556.5	170.2
43	328.0	100.3	03	385.4	117.8	63	442.7	135.4	23	500.1	152.9	83	557.5	170.5
44	328.9	100.6	04	386.3	118.1	64	443.7	135.7	24	501.1	153.2	84	558.4	170.8
45	329.9	100.9	05	387.3	118.4	65	444.6	136.0	25	502.0	153.5	85	559.4	171.1
46	330.8	101.2	06	388.2	118.7	66	445.6	136.2	26	503.0	153.8	86	560.4	171.3
47	331.8	101.5	07	389.2	119.0	67	446.6	136.5	27	503.9	154.1	87	561.3	171.6
48	332.8	101.8	08	390.1	119.3	68	447.5	136.8	28	504.9	154.4	88	562.3	171.9
49	333.7	102.0	09	391.1	119.6	69	448.5	137.1	29	505.9	154.7	89	563.2	172.2
50	334.7	102.3	10	392.0	119.9	70	449.4	137.4	30	506.8	155.0	90	564.2	172.5
351	335.6	102.6	411	393.0	120.2	471	450.4	137.7	531	507.8	155.3	591	565.1	172.8
52	336.6	102.9	12	394.0	120.5	72	451.3	138.0	32	508.7	155.6	92	566.1	173.1
53	337.5	103.2	13	394.9	120.8	73	452.3	138.3	33	509.7	155.9	93	567.1	173.4
54	338.5	103.5	14	395.9	121.0	74	453.3	138.6	34	510.6	156.2	94	568.0	173.7
55	339.5	103.8	15	396.8	121.3	75	454.2	138.9	35	511.6	156.5	95	569.0	174.0
56	340.4	104.1	16	397.8	121.6	76	455.2	139.2	36	512.6	156.8	96	569.9	174.3
57	341.4	104.4	17	398.7	121.9	77	456.1	139.5	37	513.5	157.1	97	570.9	174.6
58	342.3	104.7	18	399.7	122.2	78	457.1	139.8	38	514.5	157.3	98	571.8	174.9
59	343.3	105.0	19	400.7	122.5	79	458.0	140.0	39	515.4	157.6	99	572.8	175.2
60	344.2	105.3	20	401.6	122.8	80	459.0	140.3	40	516.4	157.9	600	573.8	175.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

73° (107°, 253°, 287°).

TABLE 2.

Difference of Latitude and Departure for 18° (162°, 198°, 342°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	1.0	0.3	61	58.0	18.9	121	115.1	37.4	181	172.1	55.9	241	229.2	74.5
2	1.9	0.6	62	59.0	19.2	22	116.0	37.7	82	173.1	56.2	42	230.2	74.8
3	2.9	0.9	63	59.9	19.5	23	117.0	38.0	83	174.0	56.6	43	231.1	75.1
4	3.8	1.2	64	60.9	19.8	24	117.9	38.3	84	175.0	56.9	44	232.1	75.4
5	4.8	1.5	65	61.8	20.1	25	118.9	38.6	85	175.9	57.2	45	233.0	75.7
6	5.7	1.9	66	62.8	20.4	26	119.8	38.9	86	176.9	57.5	46	234.0	76.0
7	6.7	2.2	67	63.7	20.7	27	120.8	39.2	87	177.8	57.8	47	234.9	76.3
8	7.6	2.5	68	64.7	21.0	28	121.7	39.6	88	178.8	58.1	48	235.9	76.6
9	8.6	2.8	69	65.6	21.3	29	122.7	39.9	89	179.7	58.4	49	236.8	76.9
10	9.5	3.1	70	66.6	21.6	30	123.6	40.2	90	180.7	58.7	50	237.8	77.3
11	10.5	3.4	71	67.5	21.9	131	124.6	40.5	191	181.7	59.0	251	238.7	77.6
12	11.4	3.7	72	68.5	22.2	32	125.5	40.8	92	182.6	59.3	52	239.7	77.9
13	12.4	4.0	73	69.4	22.6	33	126.5	41.1	93	183.6	59.6	53	240.6	78.2
14	13.3	4.3	74	70.4	22.9	34	127.4	41.4	94	184.5	59.9	54	241.6	78.5
15	14.3	4.6	75	71.3	23.2	35	128.4	41.7	95	185.5	60.3	55	242.5	78.8
16	15.2	4.9	76	72.3	23.5	36	129.3	42.0	96	186.4	60.6	56	243.5	79.1
17	16.2	5.3	77	73.2	23.8	37	130.3	42.3	97	187.4	60.9	57	244.4	79.4
18	17.1	5.6	78	74.2	24.1	38	131.2	42.6	98	188.3	61.2	58	245.4	79.7
19	18.1	5.9	79	75.1	24.4	39	132.2	43.0	99	189.3	61.5	59	246.3	80.0
20	19.0	6.2	80	76.1	24.7	40	133.1	43.3	200	190.2	61.8	60	247.3	80.3
21	20.0	6.5	81	77.0	25.0	141	134.1	43.6	201	191.2	62.1	261	248.2	80.7
22	20.9	6.8	82	78.0	25.3	42	135.1	43.9	02	192.1	62.4	62	249.2	81.0
23	21.9	7.1	83	78.9	25.6	43	136.0	44.2	03	193.1	62.7	63	250.1	81.3
24	22.8	7.4	84	79.9	26.0	44	137.0	44.5	04	194.0	63.0	64	251.1	81.6
25	23.8	7.7	85	80.8	26.3	45	137.9	44.8	05	195.0	63.3	65	252.0	81.9
26	24.7	8.0	86	81.8	26.6	46	138.9	45.1	06	195.9	63.7	66	253.0	82.2
27	25.7	8.3	87	82.7	26.9	47	139.8	45.4	07	196.9	64.0	67	253.9	82.5
28	26.6	8.7	88	83.7	27.2	48	140.8	45.7	08	197.8	64.3	68	254.9	82.8
29	27.6	9.0	89	84.6	27.5	49	141.7	46.0	09	198.8	64.6	69	255.8	83.1
30	28.5	9.3	90	85.6	27.8	50	142.7	46.4	10	199.7	64.9	70	256.8	83.4
31	29.5	9.6	91	86.5	28.1	151	143.6	46.7	211	200.7	65.2	271	257.7	83.7
32	30.4	9.9	92	87.5	28.4	52	144.6	47.0	12	201.6	65.5	72	258.7	84.1
33	31.4	10.2	93	88.4	28.7	53	145.5	47.3	13	202.6	65.8	73	259.6	84.4
34	32.3	10.5	94	89.4	29.0	54	146.5	47.6	14	203.5	66.1	74	260.6	84.7
35	33.3	10.8	95	90.4	29.4	55	147.4	47.9	15	204.5	66.4	75	261.5	85.0
36	34.2	11.1	96	91.3	29.7	56	148.4	48.2	16	205.4	66.7	76	262.5	85.3
37	35.2	11.4	97	92.3	30.0	57	149.3	48.5	17	206.4	67.1	77	263.4	85.6
38	36.1	11.7	98	93.2	30.3	58	150.3	48.8	18	207.3	67.4	78	264.4	85.9
39	37.1	12.1	99	94.2	30.6	59	151.2	49.1	19	208.3	67.7	79	265.3	86.2
40	38.0	12.4	100	95.1	30.9	60	152.2	49.4	20	209.2	68.0	80	266.3	86.5
41	39.0	12.7	101	96.1	31.2	161	153.1	49.8	221	210.2	68.3	281	267.2	86.8
42	39.9	13.0	02	97.0	31.5	62	154.1	50.1	22	211.1	68.6	82	268.2	87.1
43	40.9	13.3	03	98.0	31.8	63	155.0	50.4	23	212.1	68.9	83	269.1	87.5
44	41.8	13.6	04	98.9	32.1	64	156.0	50.7	24	213.0	69.2	84	270.1	87.8
45	42.8	13.9	05	99.9	32.4	65	156.9	51.0	25	214.0	69.5	85	271.1	88.1
46	43.7	14.2	06	100.8	32.8	66	157.9	51.3	26	214.9	69.8	86	272.0	88.4
47	44.7	14.5	07	101.8	33.1	67	158.8	51.6	27	215.9	70.1	87	273.0	88.7
48	45.7	14.8	08	102.7	33.4	68	159.8	51.9	28	216.8	70.5	88	273.9	89.0
49	46.6	15.1	09	103.7	33.7	69	160.7	52.2	29	217.8	70.8	89	274.9	89.3
50	47.6	15.5	10	104.6	34.0	70	161.7	52.5	30	218.7	71.1	90	275.8	89.6
51	48.5	15.8	111	105.6	34.3	171	162.6	52.8	231	219.7	71.4	291	276.8	89.9
52	49.5	16.1	12	106.5	34.6	72	163.6	53.2	32	220.6	71.7	92	277.7	90.2
53	50.4	16.4	13	107.5	34.9	73	164.5	53.5	33	221.6	72.0	93	278.7	90.5
54	51.4	16.7	14	108.4	35.2	74	165.5	53.8	34	222.5	72.3	94	279.6	90.9
55	52.3	17.0	15	109.4	35.5	75	166.4	54.1	35	223.5	72.6	95	280.6	91.2
56	53.3	17.3	16	110.3	35.8	76	167.4	54.4	36	224.4	72.9	96	281.5	91.5
57	54.2	17.6	17	111.3	36.2	77	168.3	54.7	37	225.4	73.2	97	282.5	91.8
58	55.2	17.9	18	112.2	36.5	78	169.3	55.0	38	226.4	73.5	98	283.4	92.1
59	56.1	18.2	19	113.2	36.8	79	170.2	55.3	39	227.3	73.9	99	284.4	92.4
60	57.1	18.5	20	114.1	37.1	80	171.2	55.6	40	228.3	74.2	300	285.3	92.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

72° (108°, 252°, 288°).

TABLE 2.

Difference of Latitude and Departure for 18° (162°, 198°, 342°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	286.3	93.0	361	343.3	111.6	421	400.4	130.1	481	457.5	148.6	541	514.5	167.2
02	287.2	93.3	62	344.3	111.9	22	401.4	130.4	82	458.5	148.9	42	515.5	167.5
03	288.2	93.7	63	345.2	112.2	23	402.3	130.7	83	459.4	149.3	43	516.4	167.9
04	289.1	94.0	64	346.2	112.5	24	403.3	131.0	84	460.4	149.6	44	517.4	168.2
05	290.1	94.3	65	347.1	112.8	25	404.2	131.3	85	461.3	149.9	45	518.3	168.5
06	291.0	94.6	66	348.1	113.1	26	405.2	131.7	86	462.3	150.2	46	519.3	168.8
07	292.0	94.9	67	349.0	113.4	27	406.1	132.0	87	463.2	150.5	47	520.2	169.1
08	292.9	95.2	68	350.0	113.7	28	407.1	132.3	88	464.2	150.8	48	521.2	169.4
09	293.9	95.5	69	350.9	114.0	29	408.0	132.6	89	465.1	151.1	49	522.1	169.7
10	294.8	95.8	70	351.9	114.3	30	409.0	132.9	90	466.1	151.4	50	523.1	170.0
311	295.8	96.1	371	352.9	114.7	431	409.9	133.2	491	467.0	151.7	551	524.0	170.3
12	296.7	96.4	72	353.8	115.0	32	410.9	133.5	92	468.0	152.0	52	525.0	170.6
13	297.7	96.7	73	354.8	115.3	33	411.8	133.8	93	468.9	152.3	53	525.9	170.9
14	298.6	97.0	74	355.7	115.6	34	412.8	134.1	94	469.8	152.6	54	526.9	171.2
15	299.6	97.4	75	356.7	115.9	35	413.7	134.4	95	470.8	153.0	55	527.8	171.5
16	300.5	97.7	76	357.6	116.2	36	414.7	134.7	96	471.7	153.3	56	528.8	171.8
17	301.5	98.0	77	358.6	116.5	37	415.6	135.1	97	472.7	153.6	57	529.7	172.1
18	302.4	98.3	78	359.5	116.8	38	416.6	135.4	98	473.6	153.9	58	530.7	172.4
19	303.4	98.6	79	360.5	117.1	39	417.5	135.7	99	474.6	154.2	59	531.6	172.7
20	304.3	98.9	80	361.4	117.4	40	418.5	136.0	500	475.5	154.5	60	532.6	173.0
321	305.3	99.2	381	362.4	117.7	441	419.4	136.3	501	476.5	154.8	561	533.5	173.3
22	306.2	99.5	82	363.3	118.1	42	420.4	136.6	02	477.4	155.1	62	534.5	173.6
23	307.2	99.8	83	364.3	118.4	43	421.3	136.9	03	478.4	155.4	63	535.4	173.9
24	308.2	100.1	84	365.2	118.7	44	422.3	137.2	04	479.3	155.7	64	536.4	174.2
25	309.1	100.4	85	366.2	119.0	45	423.2	137.5	05	480.3	156.1	65	537.3	174.6
26	310.1	100.7	86	367.1	119.3	46	424.2	137.8	06	481.2	156.4	66	538.3	174.9
27	311.0	101.1	87	368.1	119.6	47	425.1	138.1	07	482.2	156.7	67	539.2	175.2
28	312.0	101.4	88	369.0	119.9	48	426.1	138.4	08	483.2	157.0	68	540.2	175.5
29	312.9	101.7	89	370.0	120.2	49	427.0	138.8	09	484.1	157.3	69	541.1	175.8
30	313.9	102.0	90	370.9	120.5	50	428.0	139.1	10	485.1	157.6	70	542.1	176.1
331	314.8	102.3	391	371.9	120.8	451	428.9	139.4	511	486.0	157.9	571	543.0	176.4
32	315.8	102.6	92	372.8	121.1	52	429.9	139.7	12	487.0	158.2	72	544.0	176.7
33	316.7	102.9	93	373.8	121.5	53	430.8	140.0	13	487.9	158.5	73	544.9	177.0
34	317.7	103.2	94	374.7	121.8	54	431.8	140.3	14	488.9	158.8	74	545.9	177.3
35	318.6	103.5	95	375.7	122.1	55	432.7	140.6	15	489.8	159.1	75	546.8	177.6
36	319.6	103.8	96	376.6	122.4	56	433.7	140.9	16	490.8	159.4	76	547.8	178.0
37	320.5	104.1	97	377.6	122.7	57	434.6	141.2	17	491.7	159.7	77	548.7	178.3
38	321.5	104.5	98	378.5	123.0	58	435.6	141.5	18	492.7	160.0	78	549.7	178.6
39	322.4	104.8	99	379.5	123.3	59	436.5	141.8	19	493.6	160.3	79	550.6	178.9
40	323.4	105.1	400	380.4	123.6	60	437.5	142.2	20	494.6	160.7	80	551.6	179.2
341	324.3	105.4	401	381.4	123.9	461	438.4	142.5	521	495.5	161.0	581	552.5	179.5
42	325.3	105.7	02	382.3	124.2	62	439.4	142.8	22	496.5	161.3	82	553.5	179.8
43	326.2	106.0	03	383.3	124.5	63	440.3	143.1	23	497.4	161.6	83	554.4	180.1
44	327.2	106.3	04	384.2	124.9	64	441.3	143.4	24	498.4	161.9	84	555.4	180.4
45	328.1	106.6	05	385.2	125.2	65	442.2	143.7	25	499.3	162.2	85	556.3	180.7
46	329.1	106.9	06	386.1	125.5	66	443.2	144.0	26	500.3	162.5	86	557.3	181.1
47	330.0	107.2	07	387.1	125.8	67	444.2	144.3	27	501.2	162.9	87	558.2	181.4
48	331.0	107.5	08	388.0	126.1	68	445.1	144.6	28	502.2	163.2	88	559.2	181.7
49	331.9	107.9	09	389.0	126.4	69	446.1	144.9	29	503.1	163.5	89	560.1	182.0
50	332.9	108.2	10	389.9	126.7	70	447.0	145.2	30	504.1	163.8	90	561.1	182.3
351	333.8	108.5	411	390.9	127.0	471	448.0	145.6	531	505.0	164.1	591	562.0	182.7
52	334.8	108.8	12	391.8	127.3	72	448.9	145.9	32	506.0	164.4	92	563.0	183.0
53	335.7	109.1	13	392.8	127.6	73	449.9	146.2	33	506.9	164.7	93	563.9	183.3
54	336.7	109.4	14	393.7	127.9	74	450.8	146.5	34	507.9	165.0	94	564.9	183.6
55	337.6	109.7	15	394.7	128.3	75	451.8	146.8	35	508.8	165.3	95	565.8	183.9
56	338.6	110.0	16	395.6	128.6	76	452.7	147.1	36	509.8	165.6	96	566.8	184.2
57	339.5	110.3	17	396.6	128.9	77	453.7	147.4	37	510.7	165.9	97	567.7	184.5
58	340.5	110.6	18	397.5	129.2	78	454.6	147.7	38	511.7	166.2	98	568.7	184.8
59	341.4	110.9	19	398.5	129.5	79	455.6	148.0	39	512.6	166.5	99	569.6	185.1
60	342.4	111.3	20	399.5	129.8	80	456.5	148.3	40	513.6	166.9	600	570.6	185.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

72° (108, 252°, 288°).

TABLE 2.

Difference of Latitude and Departure for 19° (161°, 199°, 341°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	0.9	0.3	61	57.7	19.9	121	114.4	39.4	181	171.1	58.9	241	227.9	78.5
2	1.9	0.7	62	58.6	20.2	22	115.4	39.7	82	172.1	59.3	42	228.8	78.8
3	2.8	1.0	63	59.6	20.5	23	116.3	40.0	83	173.0	59.6	43	229.8	79.1
4	3.8	1.3	64	60.5	20.8	24	117.2	40.4	84	174.0	59.9	44	230.7	79.4
5	4.7	1.6	65	61.5	21.2	25	118.2	40.7	85	174.9	60.2	45	231.7	79.8
6	5.7	2.0	66	62.4	21.5	26	119.1	41.0	86	175.9	60.6	46	232.6	80.1
7	6.6	2.3	67	63.3	21.8	27	120.1	41.3	87	176.8	60.9	47	233.5	80.4
8	7.6	2.6	68	64.3	22.1	28	121.0	41.7	88	177.8	61.2	48	234.5	80.7
9	8.5	2.9	69	65.2	22.5	29	122.0	42.0	89	178.7	61.5	49	235.4	81.1
10	9.5	3.3	70	66.2	22.8	30	122.9	42.3	90	179.6	61.9	50	236.4	81.4
11	10.4	3.6	71	67.1	23.1	131	123.9	42.6	191	180.6	62.2	251	237.3	81.7
12	11.3	3.9	72	68.1	23.4	32	124.8	43.0	92	181.5	62.5	52	238.3	82.0
13	12.3	4.2	73	69.0	23.8	33	125.8	43.3	93	182.5	62.8	53	239.2	82.4
14	13.2	4.6	74	70.0	24.1	34	126.7	43.6	94	183.4	63.2	54	240.2	82.7
15	14.2	4.9	75	70.9	24.4	35	127.6	44.0	95	184.4	63.5	55	241.1	83.0
16	15.1	5.2	76	71.9	24.7	36	128.6	44.3	96	185.3	63.8	56	242.1	83.3
17	16.1	5.5	77	72.8	25.1	37	129.5	44.6	97	186.3	64.1	57	243.0	83.7
18	17.0	5.9	78	73.8	25.4	38	130.5	44.9	98	187.2	64.5	58	243.9	84.0
19	18.0	6.2	79	74.7	25.7	39	131.4	45.3	99	188.2	64.8	59	244.9	84.3
20	18.9	6.5	80	75.6	26.0	40	132.4	45.6	200	189.1	65.1	60	245.8	84.6
21	19.9	6.8	81	76.6	26.4	141	133.3	45.9	201	190.0	65.4	261	246.8	85.0
22	20.8	7.2	82	77.5	26.7	42	134.3	46.2	02	191.0	65.8	62	247.7	85.3
23	21.7	7.5	83	78.5	27.0	43	135.2	46.6	03	191.9	66.1	63	248.7	85.6
24	22.7	7.8	84	79.4	27.3	44	136.2	46.9	04	192.9	66.4	64	249.6	86.0
25	23.6	8.1	85	80.4	27.7	45	137.1	47.2	05	193.8	66.7	65	250.6	86.3
26	24.6	8.5	86	81.3	28.0	46	138.0	47.5	06	194.8	67.1	66	251.5	86.6
27	25.5	8.8	87	82.3	28.3	47	139.0	47.9	07	195.7	67.4	67	252.5	86.9
28	26.5	9.1	88	83.2	28.7	48	139.9	48.2	08	196.7	67.7	68	253.4	87.3
29	27.4	9.4	89	84.2	29.0	49	140.9	48.5	09	197.6	68.0	69	254.3	87.6
30	28.4	9.8	90	85.1	29.3	50	141.8	48.8	10	198.6	68.4	70	255.3	87.9
31	29.3	10.1	91	86.0	29.6	151	142.8	49.2	211	199.5	68.7	271	256.2	88.2
32	30.3	10.4	92	87.0	30.0	52	143.7	49.5	12	200.4	69.0	72	257.2	88.6
33	31.2	10.7	93	87.9	30.3	53	144.7	49.8	13	201.4	69.3	73	258.1	88.9
34	32.1	11.1	94	88.9	30.6	54	145.6	50.1	14	202.3	69.7	74	259.1	89.2
35	33.1	11.4	95	89.8	30.9	55	146.6	50.5	15	203.3	70.0	75	260.0	89.5
36	34.0	11.7	96	90.8	31.3	56	147.5	50.8	16	204.2	70.3	76	261.0	89.9
37	35.0	12.0	97	91.7	31.6	57	148.4	51.1	17	205.2	70.6	77	261.9	90.2
38	35.9	12.4	98	92.7	31.9	58	149.4	51.4	18	206.1	71.0	78	262.9	90.5
39	36.9	12.7	99	93.6	32.2	59	150.3	51.8	19	207.1	71.3	79	263.8	90.8
40	37.8	13.0	100	94.6	32.6	60	151.3	52.1	20	208.0	71.6	80	264.7	91.2
41	38.8	13.3	101	95.5	32.9	161	152.2	52.4	221	209.0	72.0	281	265.7	91.5
42	39.7	13.7	02	96.4	33.2	62	153.2	52.7	22	209.9	72.3	82	266.6	91.8
43	40.7	14.0	03	97.4	33.5	63	154.1	53.1	23	210.9	72.6	83	267.6	92.1
44	41.6	14.3	04	98.3	33.9	64	155.1	53.4	24	211.8	72.9	84	268.5	92.5
45	42.5	14.7	05	99.3	34.2	65	156.0	53.7	25	212.7	73.3	85	269.5	92.8
46	43.5	15.0	06	100.2	34.5	66	157.0	54.0	26	213.7	73.6	86	270.4	93.1
47	44.4	15.3	07	101.2	34.8	67	157.9	54.4	27	214.6	73.9	87	271.4	93.4
48	45.4	15.6	08	102.1	35.2	68	158.8	54.7	28	215.6	74.2	88	272.3	93.8
49	46.3	16.0	09	103.1	35.5	69	159.8	55.0	29	216.5	74.6	89	273.3	94.1
50	47.3	16.3	10	104.0	35.8	70	160.7	55.3	30	217.5	74.9	90	274.2	94.4
51	48.2	16.6	111	105.0	36.1	171	161.7	55.7	231	218.4	75.2	291	275.1	94.7
52	49.2	16.9	12	105.9	36.5	72	162.6	56.0	32	219.4	75.5	92	276.1	95.1
53	50.1	17.3	13	106.8	36.8	73	163.6	56.3	33	220.3	75.9	93	277.0	95.4
54	51.1	17.6	14	107.8	37.1	74	164.5	56.6	34	221.3	76.2	94	278.0	95.7
55	52.0	17.9	15	108.7	37.4	75	165.5	57.0	35	222.2	76.5	95	278.9	96.0
56	52.9	18.2	16	109.7	37.8	76	166.4	57.3	36	223.1	76.8	96	279.9	96.4
57	53.9	18.6	17	110.6	38.1	77	167.4	57.6	37	224.1	77.2	97	280.8	96.7
58	54.8	18.9	18	111.6	38.4	78	168.3	58.0	38	225.0	77.5	98	281.8	97.0
59	55.8	19.2	19	112.5	38.7	79	169.2	58.3	39	226.0	77.8	99	282.7	97.3
60	56.7	19.5	20	113.5	39.1	80	170.2	58.6	40	226.9	78.1	300	283.7	97.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

71° (109°, 251°, 289°).

TABLE 2.

Difference of Latitude and Departure for 19° (161°, 199°, 341°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	284.6	98.0	361	341.3	117.5	421	398.1	137.0	481	454.8	156.6	541	511.5	176.1
02	285.5	98.3	62	342.3	117.8	22	399.0	137.4	82	455.7	156.9	42	512.4	176.4
03	286.5	98.6	63	343.2	118.2	23	400.0	137.7	83	456.7	157.2	43	513.4	176.8
04	287.4	99.0	64	344.2	118.5	24	400.9	138.0	84	457.6	157.6	44	514.3	177.1
05	288.4	99.3	65	345.1	118.8	25	401.8	138.4	85	458.6	157.9	45	515.3	177.4
06	289.3	99.6	66	346.1	119.1	26	402.8	138.7	86	459.5	158.2	46	516.2	177.7
07	290.3	99.9	67	347.0	119.5	27	403.7	139.0	87	460.5	158.5	47	517.2	178.1
08	291.2	100.3	68	348.0	119.8	28	404.7	139.3	88	461.4	158.9	48	518.1	178.4
09	292.2	100.6	69	348.9	120.1	29	405.6	139.7	89	462.4	159.2	49	519.1	178.7
10	293.1	100.9	70	349.8	120.4	30	406.6	140.0	90	463.3	159.5	50	520.0	179.0
311	294.1	101.2	371	350.8	120.8	431	407.5	140.3	491	464.3	159.8	551	521.0	179.4
12	295.0	101.6	72	351.7	121.1	32	408.5	140.6	92	465.2	160.2	52	521.9	179.7
13	295.9	101.9	73	352.7	121.4	33	409.4	141.0	93	466.1	160.5	53	522.8	180.0
14	296.9	102.2	74	353.6	121.7	34	410.4	141.3	94	467.1	160.8	54	523.8	180.3
15	297.8	102.5	75	354.6	122.1	35	411.3	141.6	95	468.0	161.1	55	524.7	180.7
16	298.8	102.9	76	355.5	122.4	36	412.2	141.9	96	469.0	161.5	56	525.7	181.0
17	299.7	103.2	77	356.5	122.7	37	413.2	142.3	97	469.9	161.8	57	526.6	181.3
18	300.7	103.5	78	357.4	123.0	38	414.1	142.6	98	470.9	162.1	58	527.6	181.6
19	301.6	103.8	79	358.4	123.4	39	415.1	142.9	99	471.8	162.4	59	528.5	182.0
20	302.6	104.2	80	359.3	123.7	40	416.0	143.2	500	472.8	162.8	60	529.5	182.3
321	303.5	104.5	381	360.2	124.0	441	417.0	143.6	501	473.7	163.1	561	530.4	182.6
22	304.5	104.8	82	361.2	124.4	42	417.9	143.9	02	474.7	163.4	62	531.4	182.9
23	305.4	105.1	83	362.1	124.7	43	418.9	144.2	03	475.6	163.7	63	532.3	183.3
24	306.3	105.5	84	363.1	125.0	44	419.8	144.5	04	476.5	164.1	64	533.2	183.6
25	307.3	105.8	85	364.0	125.3	45	420.8	144.9	05	477.5	164.4	65	534.2	183.9
26	308.2	106.1	86	365.0	125.7	46	421.7	145.2	06	478.4	164.7	66	535.1	184.2
27	309.2	106.4	87	365.9	126.0	47	422.6	145.5	07	479.4	165.0	67	536.1	184.6
28	310.1	106.8	88	366.9	126.3	48	423.6	145.8	08	480.3	165.4	68	537.0	184.9
29	311.1	107.1	89	367.8	126.6	49	424.5	146.2	09	481.2	165.7	69	538.0	185.2
30	312.0	107.4	90	368.8	127.0	50	425.5	146.5	10	482.2	166.1	70	538.9	185.6
331	313.0	107.7	391	369.7	127.3	451	426.4	146.8	511	483.1	166.4	571	539.9	185.9
32	313.9	108.1	92	370.6	127.6	52	427.4	147.1	12	484.1	166.7	72	540.8	186.2
33	314.9	108.4	93	371.6	127.9	53	428.3	147.5	13	485.0	167.0	73	541.7	186.5
34	315.8	108.7	94	372.5	128.3	54	429.3	147.8	14	486.0	167.4	74	542.7	186.9
35	316.7	109.1	95	373.5	128.6	55	430.2	148.1	15	486.9	167.7	75	543.6	187.2
36	317.7	109.4	96	374.4	128.9	56	431.2	148.4	16	487.9	168.0	76	544.6	187.5
37	318.6	109.7	97	375.4	129.2	57	432.1	148.8	17	488.8	168.3	77	545.5	187.8
38	319.6	110.0	98	376.3	129.6	58	433.0	149.1	18	489.7	168.7	78	546.5	188.2
39	320.5	110.4	99	377.3	129.9	59	434.0	149.4	19	490.7	169.0	79	547.4	188.5
40	321.5	110.7	400	378.2	130.2	60	434.9	149.7	20	491.6	169.3	80	548.4	188.8
341	322.4	111.0	401	379.2	130.5	461	435.9	150.1	521	492.6	169.6	581	549.3	189.1
42	323.4	111.3	02	380.1	130.9	62	436.8	150.4	22	493.5	170.0	82	550.3	189.5
43	324.3	111.7	03	381.0	131.2	63	437.8	150.7	23	494.5	170.3	83	551.2	189.8
44	325.3	112.0	04	382.0	131.5	64	438.7	151.0	24	495.4	170.6	84	552.2	190.1
45	326.2	112.3	05	382.9	131.8	65	439.7	151.4	25	496.4	170.9	85	553.1	190.4
46	327.1	112.6	06	383.9	132.2	66	440.6	151.7	26	497.3	171.2	86	554.1	190.8
47	328.1	113.0	07	384.8	132.5	67	441.6	152.0	27	498.3	171.6	87	555.0	191.1
48	329.0	113.3	08	385.8	132.8	68	442.5	152.4	28	499.2	171.9	88	555.9	191.4
49	330.0	113.6	09	386.7	133.1	69	443.4	152.7	29	500.1	172.2	89	556.9	191.7
50	330.9	113.9	10	387.7	133.5	70	444.4	153.0	30	501.1	172.5	90	557.8	192.1
351	331.9	114.3	411	388.6	133.8	471	445.3	153.3	531	502.0	172.9	591	558.8	192.4
52	332.8	114.6	12	389.6	134.1	72	446.3	153.7	32	503.0	173.2	92	559.7	192.7
53	333.8	114.9	13	390.5	134.4	73	447.2	154.0	33	503.9	173.5	93	560.7	193.0
54	334.7	115.2	14	391.4	134.8	74	448.2	154.3	34	504.9	173.8	94	561.6	193.4
55	335.7	115.6	15	392.4	135.1	75	449.1	154.6	35	505.8	174.2	95	562.6	193.7
56	336.6	115.9	16	393.3	135.4	76	450.1	155.0	36	506.8	174.5	96	563.5	194.0
57	337.5	116.2	17	394.3	135.7	77	451.0	155.3	37	507.7	174.8	97	564.5	194.3
58	338.5	116.5	18	395.2	136.1	78	452.0	155.6	38	508.7	175.1	98	565.4	194.7
59	339.4	116.9	19	396.2	136.4	79	452.9	155.9	39	509.6	175.5	99	566.4	195.0
60	340.4	117.2	20	397.1	136.7	80	453.8	156.3	40	510.6	175.8	600	567.3	195.3
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

71° (109°, 251°, 289°).

TABLE 2.

Difference of Latitude and Departure for 20° (160°, 200°, 340°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	0.9	0.3	61	57.3	20.9	121	113.7	41.4	181	170.1	61.9	241	226.5	82.4
2	1.9	0.7	62	58.3	21.2	22	114.6	41.7	82	171.0	62.2	42	227.4	82.8
3	2.8	1.0	63	59.2	21.5	23	115.6	42.1	83	172.0	62.6	43	228.3	83.1
4	3.8	1.4	64	60.1	21.9	24	116.5	42.4	84	172.9	62.9	44	229.3	83.5
5	4.7	1.7	65	61.1	22.2	25	117.5	42.8	85	173.8	63.3	45	230.2	83.8
6	5.6	2.1	66	62.0	22.6	26	118.4	43.1	86	174.8	63.6	46	231.2	84.1
7	6.6	2.4	67	63.0	22.9	27	119.3	43.4	87	175.7	64.0	47	232.1	84.5
8	7.5	2.7	68	63.9	23.3	28	120.3	43.8	88	176.7	64.3	48	233.0	84.8
9	8.5	3.1	69	64.8	23.6	29	121.2	44.1	89	177.6	64.6	49	234.0	85.2
10	9.4	3.4	70	65.8	23.9	30	122.2	44.5	90	178.5	65.0	50	234.9	85.5
11	10.3	3.8	71	66.7	24.3	131	123.1	44.8	191	179.5	65.3	251	235.9	85.8
12	11.3	4.1	72	67.7	24.6	32	124.0	45.1	92	180.4	65.7	52	236.8	86.2
13	12.2	4.4	73	68.6	25.0	33	125.0	45.5	93	181.4	66.0	53	237.7	86.5
14	13.2	4.8	74	69.5	25.3	34	125.9	45.8	94	182.3	66.4	54	238.7	86.9
15	14.1	5.1	75	70.5	25.7	35	126.9	46.2	95	183.2	66.7	55	239.6	87.2
16	15.0	5.5	76	71.4	26.0	36	127.8	46.5	96	184.2	67.0	56	240.6	87.6
17	16.0	5.8	77	72.4	26.3	37	128.7	46.9	97	185.1	67.4	57	241.5	87.9
18	16.9	6.2	78	73.3	26.7	38	129.7	47.2	98	186.1	67.7	58	242.4	88.2
19	17.9	6.5	79	74.2	27.0	39	130.6	47.5	99	187.0	68.1	59	243.4	88.6
20	18.8	6.8	80	75.2	27.4	40	131.6	47.9	200	187.9	68.4	60	244.3	88.9
21	19.7	7.2	81	76.1	27.7	141	132.5	48.2	201	188.9	68.7	261	245.3	89.3
22	20.7	7.5	82	77.1	28.0	42	133.4	48.6	02	189.8	69.1	62	246.2	89.6
23	21.6	7.9	83	78.0	28.4	43	134.4	48.9	03	190.8	69.4	63	247.1	90.0
24	22.6	8.2	84	78.9	28.7	44	135.3	49.3	04	191.7	69.8	64	248.1	90.3
25	23.5	8.6	85	79.9	29.1	45	136.3	49.6	05	192.6	70.1	65	249.0	90.6
26	24.4	8.9	86	80.8	29.4	46	137.2	49.9	06	193.6	70.5	66	250.0	91.0
27	25.4	9.2	87	81.8	29.8	47	138.1	50.3	07	194.5	70.8	67	250.9	91.3
28	26.3	9.6	88	82.7	30.1	48	139.1	50.6	08	195.5	71.1	68	251.8	91.7
29	27.3	9.9	89	83.6	30.4	49	140.0	51.0	09	196.4	71.5	69	252.8	92.0
30	28.2	10.3	90	84.6	30.8	50	140.9	51.3	10	197.3	71.8	70	253.7	92.3
31	29.1	10.6	91	85.5	31.1	151	141.9	51.6	211	198.3	72.2	271	254.7	92.7
32	30.1	10.9	92	86.5	31.5	52	142.8	52.0	12	199.2	72.5	72	255.6	93.0
33	31.0	11.3	93	87.4	31.8	53	143.8	52.3	13	200.2	72.9	73	256.5	93.4
34	31.9	11.6	94	88.3	32.1	54	144.7	52.7	14	201.1	73.2	74	257.5	93.7
35	32.9	12.0	95	89.3	32.5	55	145.7	53.0	15	202.0	73.5	75	258.4	94.1
36	33.8	12.3	96	90.2	32.8	56	146.6	53.4	16	203.0	73.9	76	259.4	94.4
37	34.8	12.7	97	91.2	33.2	57	147.5	53.7	17	203.9	74.2	77	260.3	94.7
38	35.7	13.0	98	92.1	33.5	58	148.5	54.0	18	204.9	74.6	78	261.2	95.1
39	36.6	13.3	99	93.0	33.9	59	149.4	54.4	19	205.8	74.9	79	262.2	95.4
40	37.6	13.7	100	94.0	34.2	60	150.4	54.7	20	206.7	75.2	80	263.1	95.8
41	38.5	14.0	101	94.9	34.5	161	151.3	55.1	221	207.7	75.6	281	264.1	96.1
42	39.5	14.4	02	95.8	34.9	62	152.2	55.4	22	208.6	75.9	82	265.0	96.4
43	40.4	14.7	03	96.8	35.2	63	153.2	55.7	23	209.6	76.3	83	265.9	96.8
44	41.3	15.0	04	97.7	35.6	64	154.1	56.1	24	210.5	76.6	84	266.9	97.1
45	42.3	15.4	05	98.7	35.9	65	155.0	56.4	25	211.4	77.0	85	267.8	97.5
46	43.2	15.7	06	99.6	36.3	66	156.0	56.8	26	212.4	77.3	86	268.8	97.8
47	44.2	16.1	07	100.5	36.6	67	156.9	57.1	27	213.3	77.6	87	269.7	98.2
48	45.1	16.4	08	101.5	36.9	68	157.9	57.5	28	214.2	78.0	88	270.6	98.5
49	46.0	16.8	09	102.4	37.3	69	158.8	57.8	29	215.2	78.3	89	271.6	98.8
50	47.0	17.1	10	103.4	37.6	70	159.7	58.1	30	216.1	78.7	90	272.5	99.2
51	47.9	17.4	111	104.3	38.0	171	160.7	58.5	231	217.1	79.0	291	273.5	99.5
52	48.9	17.8	12	105.2	38.3	72	161.6	58.8	32	218.0	79.3	92	274.4	99.9
53	49.8	18.1	13	106.2	38.6	73	162.6	59.2	33	218.9	79.7	93	275.3	100.2
54	50.7	18.5	14	107.1	39.0	74	163.5	59.5	34	219.9	80.0	94	276.3	100.6
55	51.7	18.8	15	108.1	39.3	75	164.4	59.9	35	220.8	80.4	95	277.2	100.9
56	52.6	19.2	16	109.0	39.7	76	165.4	60.2	36	221.8	80.7	96	278.1	101.2
57	53.6	19.5	17	109.9	40.0	77	166.3	60.5	37	222.7	81.1	97	279.1	101.6
58	54.5	19.8	18	110.9	40.4	78	167.3	60.9	38	223.6	81.4	98	280.0	101.9
59	55.4	20.2	19	111.8	40.7	79	168.2	61.2	39	224.6	81.7	99	281.0	102.3
60	56.4	20.5	20	112.8	41.0	80	169.1	61.6	40	225.5	82.1	300	281.9	102.6
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

70° (110°, 250°, 290°).

TABLE 2.

Difference of Latitude and Departure for 20° (160°, 200°, 340°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	282.9	103.0	361	339.2	123.5	421	395.6	144.0	481	452.0	164.5	541	508.4	185.0
02	283.8	103.3	62	340.2	123.8	22	396.6	144.3	82	453.0	164.8	42	509.3	185.4
03	284.7	103.6	63	341.1	124.2	23	397.5	144.7	83	453.9	165.2	43	510.3	185.7
04	285.7	104.0	64	342.1	124.5	24	398.4	145.0	84	454.8	165.5	44	511.2	186.0
05	286.6	104.3	65	343.0	124.8	25	399.4	145.4	85	455.8	165.9	45	512.1	186.4
06	287.6	104.7	66	343.9	125.2	26	400.3	145.7	86	456.7	166.3	46	513.1	186.8
07	288.5	105.0	67	344.9	125.5	27	401.3	146.1	87	457.7	166.6	47	514.0	187.1
08	289.4	105.4	68	345.8	125.9	28	402.2	146.4	88	458.6	166.9	48	515.0	187.4
09	290.4	105.7	69	346.8	126.2	29	403.1	146.7	89	459.5	167.3	49	515.9	187.8
10	291.3	106.0	70	347.7	126.6	30	404.1	147.1	90	460.5	167.7	50	516.8	188.2
311	292.3	106.4	371	348.6	126.9	431	405.0	147.4	491	461.4	168.0	551	517.8	188.5
12	293.2	106.7	72	349.6	127.2	32	406.0	147.8	92	462.4	168.3	52	518.7	188.8
13	294.1	107.1	73	350.5	127.6	33	406.9	148.1	93	463.3	168.6	53	519.7	189.1
14	295.1	107.4	74	351.5	127.9	34	407.8	148.4	94	464.2	168.9	54	520.6	189.4
15	296.0	107.7	75	352.4	128.3	35	408.8	148.8	95	465.2	169.3	55	521.5	189.8
16	297.0	108.1	76	353.3	128.6	36	409.7	149.1	96	466.1	169.6	56	522.5	190.2
17	297.9	108.4	77	354.3	129.0	37	410.7	149.5	97	467.0	170.0	57	523.4	190.5
18	298.8	108.8	78	355.2	129.3	38	411.6	149.8	98	468.0	170.3	58	524.4	190.8
19	299.8	109.1	79	356.2	129.6	39	412.5	150.2	99	468.9	170.7	59	525.3	191.2
20	300.7	109.5	80	357.1	130.0	40	413.5	150.5	500	469.9	171.0	60	526.2	191.6
321	301.6	109.8	381	358.0	130.3	441	414.4	150.8	501	470.8	171.3	561	527.2	191.9
22	302.6	110.1	82	359.0	130.7	42	415.4	151.2	02	471.7	171.7	62	528.1	192.2
23	303.5	110.5	83	359.9	131.0	43	416.3	151.5	03	472.7	172.0	63	529.0	192.5
24	304.5	110.8	84	360.8	131.3	44	417.2	151.9	04	473.6	172.4	64	530.0	192.9
25	305.4	111.2	85	361.8	131.7	45	418.2	152.2	05	474.5	172.7	65	530.9	193.2
26	306.3	111.5	86	362.7	132.0	46	419.1	152.5	06	475.4	173.0	66	531.8	193.6
27	307.3	111.8	87	363.7	132.4	47	420.0	152.9	07	476.4	173.4	67	532.8	193.9
28	308.2	112.2	88	364.6	132.7	48	421.0	153.2	08	477.3	173.7	68	533.7	194.2
29	309.2	112.5	89	365.5	133.1	49	421.9	153.6	09	478.3	174.1	69	534.7	194.6
30	310.1	112.9	90	366.5	133.4	50	422.9	153.9	10	479.2	174.4	70	535.6	195.0
331	311.0	113.2	391	367.4	133.7	451	423.8	154.3	511	480.2	174.8	571	536.6	195.3
32	312.0	113.6	92	368.4	134.1	52	424.7	154.6	12	481.1	175.1	72	537.5	195.6
33	312.9	113.9	93	369.3	134.4	53	425.7	154.9	13	482.1	175.4	73	538.5	195.9
34	313.9	114.2	94	370.2	134.8	54	426.6	155.3	14	483.0	175.8	74	539.4	196.3
35	314.8	114.6	95	371.2	135.1	55	427.6	155.6	15	484.0	176.1	75	540.3	196.6
36	315.7	114.9	96	372.1	135.4	56	428.5	156.0	16	484.9	176.5	76	541.3	197.0
37	316.7	115.3	97	373.1	135.8	57	429.4	156.3	17	485.8	176.8	77	542.2	197.3
38	317.6	115.6	98	374.0	136.1	58	430.4	156.7	18	486.8	177.2	78	543.2	197.7
39	318.6	116.0	99	374.9	136.5	59	431.3	157.0	19	487.7	177.5	79	544.1	198.0
40	319.5	116.3	400	375.9	136.8	60	432.3	157.4	20	488.7	177.9	80	545.0	198.4
341	320.4	116.6	401	376.8	137.2	461	433.2	157.7	521	489.6	178.2	581	546.0	198.7
42	321.4	117.0	02	377.8	137.5	62	434.1	158.0	22	490.5	178.5	82	546.9	199.0
43	322.3	117.3	03	378.7	137.8	63	435.1	158.4	23	491.5	178.9	83	547.9	199.4
44	323.3	117.7	04	379.6	138.2	64	436.0	158.7	24	492.4	179.2	84	548.8	199.8
45	324.2	118.0	05	380.6	138.5	65	437.0	159.0	25	493.4	179.6	85	549.8	200.1
46	325.1	118.4	06	381.5	138.9	66	437.9	159.4	26	494.3	179.9	86	550.7	200.4
47	326.1	118.7	07	382.5	139.2	67	438.8	159.7	27	495.3	180.2	87	551.7	200.8
48	327.0	119.0	08	383.4	139.6	68	439.8	160.1	28	496.2	180.6	88	552.6	201.2
49	328.0	119.4	09	384.3	139.9	69	440.7	160.4	29	497.1	181.0	89	553.5	201.5
50	328.9	119.7	10	385.3	140.2	70	441.7	160.8	30	498.1	181.3	90	554.4	201.8
351	329.8	120.1	411	386.2	140.6	471	442.6	161.1	531	499.0	181.6	591	555.4	202.1
52	330.8	120.4	12	387.2	140.9	72	443.5	161.4	32	499.9	181.9	92	556.3	202.4
53	331.7	120.7	13	388.1	141.3	73	444.5	161.8	33	500.9	182.3	93	557.3	202.8
54	332.7	121.1	14	389.0	141.6	74	445.4	162.1	34	501.8	182.6	94	558.2	203.2
55	333.6	121.4	15	390.0	141.9	75	446.4	162.5	35	502.7	183.0	95	559.1	203.5
56	334.5	121.8	16	390.9	142.3	76	447.3	162.8	36	503.7	183.3	96	560.0	203.8
57	335.5	122.1	17	391.9	142.6	77	448.2	163.2	37	504.6	183.7	97	561.0	204.2
58	336.4	122.5	18	392.8	143.0	78	449.2	163.5	38	505.5	184.0	98	561.9	204.6
59	337.4	122.8	19	393.7	143.3	79	450.1	163.8	39	506.5	184.3	99	562.9	204.9
60	338.3	123.1	20	394.7	143.7	80	451.1	164.2	40	507.4	184.7	600	563.8	205.2
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

70° (110°, 250°, 290°).

TABLE 2.

Difference of Latitude and Departure for 21° (159°, 201°, 339°).

Dist	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	0.9	0.4	61	56.9	21.9	121	113.0	43.4	181	169.0	64.9	241	225.0	86.4
2	1.9	0.7	62	57.9	22.2	22	113.9	43.7	82	169.9	65.2	42	225.9	86.7
3	2.8	1.1	63	58.8	22.6	23	114.8	44.1	83	170.8	65.6	43	226.9	87.1
4	3.7	1.4	64	59.7	22.9	24	115.8	44.4	84	171.8	65.9	44	227.8	87.4
5	4.7	1.8	65	60.7	23.3	25	116.7	44.8	85	172.7	66.3	45	228.7	87.8
6	5.6	2.2	66	61.6	23.7	26	117.6	45.2	86	173.6	66.7	46	229.7	88.2
7	6.5	2.5	67	62.5	24.0	27	118.6	45.5	87	174.6	67.0	47	230.6	88.5
8	7.5	2.9	68	63.5	24.4	28	119.5	45.9	88	175.5	67.4	48	231.5	88.9
9	8.4	3.2	69	64.4	24.7	29	120.4	46.2	89	176.4	67.7	49	232.5	89.2
10	9.3	3.6	70	65.4	25.1	30	121.4	46.6	90	177.4	68.1	50	233.4	89.6
11	10.3	3.9	71	66.3	25.4	131	122.3	46.9	191	178.3	68.4	251	234.3	90.0
12	11.2	4.3	72	67.2	25.8	32	123.2	47.3	92	179.2	68.8	52	235.3	90.3
13	12.1	4.7	73	68.2	26.2	33	124.2	47.7	93	180.2	69.2	53	236.2	90.7
14	13.1	5.0	74	69.1	26.5	34	125.1	48.0	94	181.1	69.5	54	237.1	91.0
15	14.0	5.4	75	70.0	26.9	35	126.0	48.4	95	182.0	69.9	55	238.1	91.4
16	14.9	5.7	76	71.0	27.2	36	127.0	48.7	96	183.0	70.2	56	239.0	91.7
17	15.9	6.1	77	71.9	27.6	37	127.9	49.1	97	183.9	70.6	57	239.9	92.1
18	16.8	6.5	78	72.8	28.0	38	128.8	49.5	98	184.8	71.0	58	240.9	92.5
19	17.7	6.8	79	73.8	28.3	39	129.8	49.8	99	185.8	71.3	59	241.8	92.8
20	18.7	7.2	80	74.7	28.7	40	130.7	50.2	200	186.7	71.7	60	242.7	93.2
21	19.6	7.5	81	75.6	29.0	141	131.6	50.5	201	187.6	72.0	261	243.7	93.5
22	20.5	7.9	82	76.6	29.4	42	132.6	50.9	02	188.6	72.4	62	244.6	93.9
23	21.5	8.2	83	77.5	29.7	43	133.5	51.2	03	189.5	72.7	63	245.5	94.3
24	22.4	8.6	84	78.4	30.1	44	134.4	51.6	04	190.5	73.1	64	246.5	94.6
25	23.3	9.0	85	79.4	30.5	45	135.4	52.0	05	191.4	73.5	65	247.4	95.0
26	24.3	9.3	86	80.3	30.8	46	136.3	52.3	06	192.3	73.8	66	248.3	95.3
27	25.2	9.7	87	81.2	31.2	47	137.2	52.7	07	193.3	74.2	67	249.3	95.7
28	26.1	10.0	88	82.2	31.5	48	138.2	53.0	08	194.2	74.5	68	250.2	96.0
29	27.1	10.4	89	83.1	31.9	49	139.1	53.4	09	195.1	74.9	69	251.1	96.4
30	28.0	10.8	90	84.0	32.3	50	140.0	53.8	10	196.1	75.3	70	252.1	96.8
31	28.9	11.1	91	85.0	32.6	151	141.0	54.1	211	197.0	75.6	271	253.0	97.1
32	29.9	11.5	92	85.9	33.0	52	141.9	54.5	12	197.9	76.0	72	253.9	97.5
33	30.8	11.8	93	86.8	33.3	53	142.8	54.8	13	198.9	76.3	73	254.9	97.8
34	31.7	12.2	94	87.8	33.7	54	143.8	55.2	14	199.8	76.7	74	255.8	98.2
35	32.7	12.5	95	88.7	34.0	55	144.7	55.5	15	200.7	77.0	75	256.7	98.6
36	33.6	12.9	96	89.6	34.4	56	145.6	55.9	16	201.7	77.4	76	257.7	98.9
37	34.5	13.3	97	90.6	34.8	57	146.6	56.3	17	202.6	77.8	77	258.6	99.3
38	35.5	13.6	98	91.5	35.1	58	147.5	56.6	18	203.5	78.1	78	259.5	99.6
39	36.4	14.0	99	92.4	35.5	59	148.4	57.0	19	204.5	78.5	79	260.5	100.0
40	37.3	14.3	100	93.4	35.8	60	149.4	57.3	20	205.4	78.8	80	261.4	100.3
41	38.3	14.7	101	94.3	36.2	161	150.3	57.7	221	206.3	79.2	281	262.3	100.7
42	39.2	15.1	02	95.2	36.6	62	151.2	58.1	22	207.3	79.6	82	263.3	101.1
43	40.1	15.4	03	96.2	36.9	63	152.2	58.4	23	208.2	79.9	83	264.2	101.4
44	41.1	15.8	04	97.1	37.3	64	153.1	58.8	24	209.1	80.3	84	265.1	101.8
45	42.0	16.1	05	98.0	37.6	65	154.0	59.1	25	210.1	80.6	85	266.1	102.1
46	42.9	16.5	06	99.0	38.0	66	155.0	59.5	26	211.0	81.0	86	267.0	102.5
47	43.9	16.8	07	99.9	38.3	67	155.9	59.8	27	211.9	81.3	87	267.9	102.9
48	44.8	17.2	08	100.8	38.7	68	156.8	60.2	28	212.9	81.7	88	268.9	103.2
49	45.7	17.6	09	101.8	39.1	69	157.8	60.6	29	213.8	82.1	89	269.8	103.6
50	46.7	17.9	10	102.7	39.4	70	158.7	60.9	30	214.7	82.4	90	270.7	103.9
51	47.6	18.3	111	103.6	39.8	171	159.6	61.3	231	215.7	82.8	291	271.7	104.3
52	48.5	18.6	12	104.6	40.1	72	160.6	61.6	32	216.6	83.1	92	272.6	104.6
53	49.5	19.0	13	105.5	40.5	73	161.5	62.0	33	217.5	83.5	93	273.5	105.0
54	50.4	19.4	14	106.4	40.9	74	162.4	62.4	34	218.5	83.9	94	274.5	105.4
55	51.3	19.7	15	107.4	41.2	75	163.4	62.7	35	219.4	84.2	95	275.4	105.7
56	52.3	20.1	16	108.3	41.6	76	164.3	63.1	36	220.3	84.6	96	276.3	106.1
57	53.2	20.4	17	109.2	41.9	77	165.2	63.4	37	221.3	84.9	97	277.3	106.4
58	54.1	20.8	18	110.2	42.3	78	166.2	63.8	38	222.2	85.3	98	278.2	106.8
59	55.1	21.1	19	111.1	42.6	79	167.1	64.1	39	223.1	85.6	99	279.1	107.2
60	56.0	21.5	20	112.0	43.0	80	168.0	64.5	40	224.1	86.0	300	280.1	107.5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

69° (111°, 249°, 291°).

TABLE 2.

Difference of Latitude and Departure for 21° (159°, 201°, 339°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	281.0	107.9	361	337.0	129.4	421	393.0	150.9	481	449.0	172.4	541	505.1	193.9
02	281.9	108.2	62	337.9	129.7	22	394.0	151.2	82	450.0	172.7	42	506.0	194.2
03	282.9	108.6	63	338.9	130.1	23	394.9	151.6	83	450.9	173.1	43	507.0	194.6
04	283.8	108.9	64	339.8	130.4	24	395.8	152.0	84	451.8	173.5	44	507.9	195.0
05	284.7	109.3	65	340.7	130.8	25	396.8	152.3	85	452.8	173.8	45	508.8	195.3
06	285.7	109.7	66	341.7	131.2	26	397.7	152.7	86	453.7	174.2	46	509.8	195.7
07	286.6	110.0	67	342.6	131.5	27	398.6	153.0	87	454.6	174.5	47	510.7	196.0
08	287.5	110.4	68	343.5	131.9	28	399.6	153.4	88	455.6	174.9	48	511.6	196.4
09	288.5	110.7	79	344.5	132.2	29	400.5	153.7	89	456.5	175.2	49	512.6	196.8
10	289.4	111.1	70	345.4	132.6	30	401.4	154.1	90	457.4	175.6	50	513.5	197.1
311	290.3	111.5	371	346.3	133.0	431	402.4	154.5	491	458.4	176.0	551	514.4	197.5
12	291.3	111.8	72	347.3	133.3	32	403.3	154.8	92	459.3	176.3	52	515.4	197.8
13	292.2	112.2	73	348.2	133.7	33	404.2	155.2	93	460.2	176.7	53	516.3	198.2
14	293.1	112.5	74	349.1	134.0	34	405.2	155.5	94	461.2	177.0	54	517.2	198.6
15	294.1	112.9	75	350.1	134.4	35	406.1	155.9	95	462.1	177.4	55	518.2	198.9
16	295.0	113.2	76	351.0	134.7	36	407.0	156.3	96	463.0	177.8	56	519.1	199.3
17	295.9	113.6	77	351.9	135.1	37	408.0	156.6	97	464.0	178.1	57	520.0	199.6
18	296.9	114.0	78	352.9	135.5	38	408.9	157.0	98	464.9	178.5	58	521.0	200.0
19	297.8	114.3	79	353.8	135.8	39	409.8	157.3	99	465.8	178.8	59	521.9	200.3
20	298.7	114.7	80	354.7	136.2	40	410.8	157.7	500	466.8	179.2	60	522.8	200.7
321	299.7	115.0	381	355.7	136.5	441	411.7	158.0	501	467.7	179.5	561	523.8	201.0
22	300.6	115.4	82	356.6	136.9	42	412.6	158.4	02	468.6	179.9	62	524.7	201.4
23	301.5	115.8	83	357.5	137.3	43	413.6	158.8	03	469.6	180.3	63	525.6	201.8
24	302.5	116.1	84	358.5	137.6	44	414.5	159.1	04	470.5	180.6	64	526.6	202.1
25	303.4	116.5	85	359.4	138.0	45	415.4	159.5	05	471.5	181.0	65	527.5	202.5
26	304.3	116.8	86	360.3	138.3	46	416.4	159.8	06	472.4	181.3	66	528.4	202.8
27	305.3	117.2	87	361.3	138.7	47	417.3	160.2	07	473.3	181.7	67	529.4	203.2
28	306.2	117.5	88	362.2	139.1	48	418.2	160.5	08	474.3	182.0	68	530.3	203.5
29	307.1	117.9	89	363.1	139.4	49	419.2	160.9	09	475.2	182.4	69	531.2	203.9
30	308.1	118.3	90	364.1	139.8	50	420.1	161.3	10	476.1	182.8	70	532.2	204.3
331	309.0	118.6	391	365.0	140.1	451	421.0	161.6	511	477.1	183.1	571	533.1	204.6
32	309.9	119.0	92	365.9	140.5	52	422.0	162.0	12	478.0	183.5	72	534.0	205.0
33	310.9	119.3	93	366.9	140.8	53	422.9	162.3	13	478.9	183.8	73	535.0	205.4
34	311.8	119.7	94	367.8	141.2	54	423.8	162.7	14	479.9	184.2	74	535.9	205.7
35	312.7	120.1	95	368.7	141.6	55	424.8	163.1	15	480.8	184.6	75	536.8	206.1
36	313.7	120.4	96	369.7	141.9	56	425.7	163.4	16	481.7	184.9	76	537.8	206.4
37	314.6	120.8	97	370.6	142.3	57	426.6	163.8	17	482.7	185.3	77	538.7	206.8
38	315.5	121.1	98	371.5	142.6	58	427.6	164.1	18	483.6	185.6	78	539.6	207.1
39	316.5	121.5	99	372.5	143.0	59	428.5	164.5	19	484.5	186.0	79	540.6	207.5
40	317.4	121.8	400	373.4	143.4	60	429.4	164.9	20	485.5	186.4	80	541.5	207.9
341	318.3	122.2	401	374.3	143.7	461	430.4	165.2	521	486.4	186.7	581	542.4	208.2
42	319.3	122.6	02	375.3	144.1	62	431.3	165.6	22	487.3	187.1	82	543.4	208.6
43	320.2	122.9	03	376.2	144.4	63	432.2	165.9	23	488.3	187.4	83	544.3	208.9
44	321.1	123.2	04	377.1	144.8	64	433.2	166.3	24	489.2	187.8	84	545.2	209.3
45	322.1	123.6	05	378.1	145.1	65	434.1	166.6	25	490.1	188.1	85	546.2	209.6
46	323.0	124.0	06	379.0	145.5	66	435.0	167.0	26	491.1	188.5	86	547.1	210.0
47	323.9	124.4	07	379.9	145.9	67	436.0	167.4	27	492.0	188.9	87	548.0	210.4
48	324.9	124.7	08	380.9	146.2	68	436.9	167.7	28	492.9	189.2	88	549.0	210.7
49	325.8	125.1	09	381.8	146.6	69	437.8	168.1	29	493.9	189.6	89	549.9	211.1
50	326.7	125.4	10	382.7	146.9	70	438.8	168.4	30	494.8	189.9	90	550.8	211.4
351	327.7	125.8	411	383.7	147.3	471	439.7	168.8	531	495.7	190.3	591	551.8	211.8
52	328.6	126.1	12	384.6	147.7	72	440.6	169.2	32	496.7	190.7	92	552.7	212.2
53	329.5	126.5	13	385.5	148.0	73	441.6	169.5	33	497.6	191.0	93	553.6	212.5
54	330.5	126.9	14	386.5	148.4	74	442.5	169.9	34	498.5	191.4	94	554.6	212.9
55	331.4	127.2	15	387.4	148.7	75	443.4	170.2	35	499.5	191.7	95	555.5	213.2
56	332.3	127.6	16	388.4	149.1	76	444.4	170.6	36	500.4	192.1	96	556.4	213.6
57	333.3	127.9	17	389.3	149.4	77	445.3	170.9	37	501.3	192.4	97	557.4	213.9
58	334.2	128.3	18	390.2	149.8	78	446.2	171.3	38	502.3	192.8	98	558.2	214.3
59	335.1	128.7	19	391.2	150.2	79	447.2	171.7	39	503.2	193.2	99	559.2	214.7
60	336.1	129.0	20	392.1	150.5	80	448.1	172.0	40	504.1	193.5	600	560.1	215.0
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

69° (111°, 249°, 291°).

TABLE 2.

Difference of Latitude and Departure for 22° (158°, 202, 338°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	0.9	0.4	61	56.6	22.9	121	112.2	45.3	181	167.8	67.8	241	223.5	90.3
2	1.9	0.7	62	57.5	23.2	22	113.1	45.7	82	168.7	68.2	42	224.4	90.7
3	2.8	1.1	63	58.4	23.6	23	114.0	46.1	83	169.7	68.6	43	225.3	91.0
4	3.7	1.5	64	59.3	24.0	24	115.0	46.5	84	170.6	68.9	44	226.2	91.4
5	4.6	1.9	65	60.3	24.3	25	115.9	46.8	85	171.5	69.3	45	227.2	91.8
6	5.6	2.2	66	61.2	24.7	26	116.8	47.2	86	172.5	69.7	46	228.1	92.2
7	6.5	2.6	67	62.1	25.1	27	117.8	47.6	87	173.4	70.1	47	229.0	92.5
8	7.4	3.0	68	63.0	25.5	28	118.7	47.9	88	174.3	70.4	48	229.9	92.9
9	8.3	3.4	69	64.0	25.8	29	119.6	48.3	89	175.2	70.8	49	230.9	93.3
10	9.3	3.7	70	64.9	26.2	30	120.5	48.7	90	176.2	71.2	50	231.8	93.7
11	10.2	4.1	71	65.8	26.6	131	121.5	49.1	191	177.1	71.5	251	232.7	94.0
12	11.1	4.5	72	66.8	27.0	32	122.4	49.4	92	178.0	71.9	52	233.7	94.4
13	12.1	4.9	73	67.7	27.3	33	123.3	49.8	93	178.9	72.3	53	234.6	94.8
14	13.0	5.2	74	68.6	27.7	34	124.2	50.2	94	179.9	72.7	54	235.5	95.2
15	13.9	5.6	75	69.5	28.1	35	125.2	50.6	95	180.8	73.0	55	236.4	95.5
16	14.8	6.0	76	70.5	28.5	36	126.1	50.9	96	181.7	73.4	56	237.4	95.9
17	15.8	6.4	77	71.4	28.8	37	127.0	51.3	97	182.7	73.8	57	238.3	96.3
18	16.7	6.7	78	72.3	29.2	38	128.0	51.7	98	183.6	74.2	58	239.2	96.6
19	17.6	7.1	79	73.2	29.6	39	128.9	52.1	99	184.5	74.5	59	240.1	97.0
20	18.5	7.5	80	74.2	30.0	40	129.8	52.4	200	185.4	74.9	60	241.1	97.4
21	19.5	7.9	81	75.1	30.3	141	130.7	52.8	201	186.4	75.3	261	242.0	97.8
22	20.4	8.2	82	76.0	30.7	42	131.7	53.2	02	187.3	75.7	62	242.9	98.1
23	21.3	8.6	83	77.0	31.1	43	132.6	53.6	03	188.2	76.0	63	243.8	98.5
24	22.3	9.0	84	77.9	31.5	44	133.5	53.9	04	189.1	76.4	64	244.8	98.9
25	23.2	9.4	85	78.8	31.8	45	134.4	54.3	05	190.1	76.8	65	245.7	99.3
26	24.1	9.7	86	79.7	32.2	46	135.4	54.7	06	191.0	77.2	66	246.6	99.6
27	25.0	10.1	87	80.7	32.6	47	136.3	55.1	07	191.9	77.5	67	247.6	100.0
28	26.0	10.5	88	81.6	33.0	48	137.2	55.4	08	192.9	77.9	68	248.5	100.4
29	26.9	10.9	89	82.5	33.3	49	138.2	55.8	09	193.8	78.3	69	249.4	100.8
30	27.8	11.2	90	83.4	33.7	50	139.1	56.2	10	194.7	78.7	70	250.3	101.1
31	28.7	11.6	91	84.4	34.1	151	140.0	56.6	211	195.6	79.0	271	251.3	101.5
32	29.7	12.0	92	85.3	34.5	52	140.9	56.9	12	196.6	79.4	72	252.2	101.9
33	30.6	12.4	93	86.2	34.8	53	141.9	57.3	13	197.5	79.8	73	253.1	102.3
34	31.5	12.7	94	87.2	35.2	54	142.8	57.7	14	198.4	80.2	74	254.0	102.6
35	32.5	13.1	95	88.1	35.6	55	143.7	58.1	15	199.3	80.5	75	255.0	103.0
36	33.4	13.5	96	89.0	36.0	56	144.6	58.4	16	200.3	80.9	76	255.9	103.4
37	34.3	13.9	97	89.9	36.3	57	145.6	58.8	17	201.2	81.3	77	256.8	103.8
38	35.2	14.2	98	90.9	36.7	58	146.5	59.2	18	202.1	81.7	78	257.8	104.1
39	36.2	14.6	99	91.8	37.1	59	147.4	59.6	19	203.1	82.0	79	258.7	104.5
40	37.1	15.0	100	92.7	37.5	60	148.3	59.9	20	204.0	82.4	80	259.6	104.9
41	38.0	15.4	101	93.6	37.8	161	149.3	60.3	221	204.9	82.8	281	260.5	105.3
42	38.9	15.7	02	94.6	38.2	62	150.2	60.7	22	205.8	83.2	82	261.5	105.6
43	39.9	16.1	03	95.5	38.6	63	151.1	61.1	23	206.8	83.5	83	262.4	106.0
44	40.8	16.5	04	96.4	39.0	64	152.1	61.4	24	207.7	83.9	84	263.3	106.4
45	41.7	16.9	05	97.4	39.3	65	153.0	61.8	25	208.6	84.3	85	264.2	106.8
46	42.7	17.2	06	98.3	39.7	66	153.9	62.2	26	209.5	84.7	86	265.2	107.1
47	43.6	17.6	07	99.2	40.1	67	154.8	62.6	27	210.5	85.0	87	266.1	107.5
48	44.5	18.0	08	100.1	40.5	68	155.8	62.9	28	211.4	85.4	88	267.0	107.9
49	45.4	18.4	09	101.1	40.8	69	156.7	63.3	29	212.3	85.8	89	268.0	108.3
50	46.4	18.7	10	102.0	41.2	70	157.6	63.7	30	213.3	86.2	90	268.9	108.6
51	47.3	19.1	111	102.9	41.6	171	158.5	64.1	231	214.2	86.5	291	269.8	109.0
52	48.2	19.5	12	103.8	42.0	72	159.5	64.4	32	215.1	86.9	92	270.7	109.4
53	49.1	19.9	13	104.8	42.3	73	160.4	64.8	33	216.0	87.3	93	271.7	109.8
54	50.1	20.2	14	105.7	42.7	74	161.3	65.2	34	217.0	87.7	94	272.6	110.1
55	51.0	20.6	15	106.6	43.1	75	162.3	65.6	35	217.9	88.0	95	273.5	110.5
56	51.9	21.0	16	107.6	43.5	76	163.2	65.9	36	218.8	88.4	96	274.4	110.9
57	52.8	21.4	17	108.5	43.8	77	164.1	66.3	37	219.7	88.8	97	275.4	111.3
58	53.8	21.7	18	109.4	44.2	78	165.0	66.7	38	220.7	89.2	98	276.3	111.6
59	54.7	22.1	19	110.3	44.6	79	166.0	67.1	39	221.6	89.5	99	277.2	112.0
60	55.6	22.5	20	111.3	45.0	80	166.9	67.4	40	222.5	89.9	300	278.2	112.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

68° (112°, 248°, 292°).

TABLE 2.

Difference of Latitude and Departure for 22° (158°, 202°, 338°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep
301	279.1	112.7	361	334.7	135.2	421	390.3	157.7	481	446.0	180.2	541	501.6	202.
02	280.0	113.1	62	335.6	135.6	22	391.3	158.1	82	446.9	180.6	42	502.5	203.
03	280.9	113.5	63	336.6	136.0	23	392.2	158.4	83	447.8	180.9	43	503.4	203.
04	281.9	113.9	64	337.5	136.3	24	393.1	158.8	84	448.8	181.3	44	504.4	203.
05	282.8	114.2	65	338.4	136.7	25	394.1	159.2	85	449.7	181.7	45	505.3	204.
06	283.7	114.6	66	339.3	137.1	26	395.0	159.6	86	450.6	182.1	46	506.2	204.
07	284.6	115.0	67	340.3	137.5	27	395.9	159.9	87	451.6	182.4	47	507.2	205.
08	285.6	115.4	68	341.2	137.8	28	396.8	160.3	88	452.5	182.8	48	508.1	205.
09	286.5	115.7	69	342.1	138.2	29	397.8	160.7	89	453.4	183.2	49	509.0	205.
10	287.4	116.1	70	343.1	138.6	30	398.7	161.1	90	454.3	183.6	50	510.0	206.
311	288.4	116.5	371	344.0	139.0	431	399.6	161.4	491	455.3	184.0	551	510.9	206.
12	289.3	116.8	72	344.9	139.3	32	400.5	161.8	92	456.2	184.3	52	511.8	206.
13	290.2	117.2	73	345.8	139.7	33	401.5	162.2	93	457.1	184.7	53	512.7	207.
14	291.1	117.6	74	346.8	140.1	34	402.4	162.6	94	458.0	185.1	54	513.6	207.
15	292.1	118.0	75	347.7	140.5	35	403.3	162.9	95	459.0	185.4	55	514.6	208.
16	293.0	118.3	76	348.6	140.8	36	404.3	163.3	96	459.9	185.8	56	515.5	208.
17	293.9	118.7	77	349.5	141.2	37	405.2	163.7	97	460.8	186.2	57	516.4	208.
18	294.8	119.1	78	350.5	141.6	38	406.1	164.1	98	461.8	186.6	58	517.4	209.
19	295.8	119.5	79	351.4	141.9	39	407.0	164.4	99	462.7	186.9	59	518.3	209.
20	296.7	119.8	80	352.3	142.3	40	408.0	164.8	500	463.6	187.3	60	519.2	209.
321	297.6	120.2	381	353.3	142.7	441	408.9	165.2	501	464.5	187.7	561	520.1	210.
22	298.6	120.6	82	354.2	143.1	42	409.8	165.5	02	465.4	188.0	62	521.0	210.
23	299.5	121.0	83	355.1	143.4	43	410.7	165.9	03	466.4	188.4	63	522.0	210.
24	300.4	121.3	84	356.0	143.8	44	411.7	166.3	04	467.3	188.8	64	522.9	211.
25	301.3	121.7	85	357.0	144.2	45	412.6	166.7	05	468.2	189.2	65	523.8	211.
26	302.3	122.1	86	357.9	144.6	46	413.5	167.0	06	469.2	189.5	66	524.8	212.
27	303.2	122.5	87	358.8	144.9	47	414.5	167.4	07	470.1	189.9	67	525.7	212.
28	304.1	122.8	88	359.7	145.3	48	415.4	167.8	08	471.0	190.3	68	526.6	212.
29	305.0	123.2	89	360.7	145.7	49	416.3	168.2	09	471.9	190.7	69	527.5	213.
30	306.0	123.6	90	361.6	146.1	50	417.2	168.5	10	472.9	191.1	70	528.5	213.
331	306.9	124.0	391	362.5	146.4	451	418.2	168.9	511	473.8	191.4	571	529.4	213.
32	307.8	124.3	92	363.5	146.8	52	419.1	169.3	12	474.7	191.8	72	530.3	214.
33	308.8	124.7	93	364.4	147.2	53	420.0	169.7	13	475.6	192.2	73	531.2	214.
34	309.7	125.1	94	365.3	147.6	54	420.9	170.0	14	476.6	192.5	74	532.2	215.
35	310.6	125.5	95	366.2	147.9	55	421.9	170.4	15	477.5	192.9	75	533.1	215.
36	311.5	125.8	96	367.2	148.3	56	422.8	170.8	16	478.4	193.3	76	534.0	215.
37	312.5	126.2	97	368.1	148.7	57	423.7	171.2	17	479.3	193.7	77	534.9	216.
38	313.4	126.6	98	369.0	149.1	58	424.6	171.5	18	480.3	194.0	78	535.9	216.
39	314.3	127.0	99	369.9	149.4	59	425.6	171.9	19	481.2	194.4	79	536.8	216.
40	315.2	127.3	400	370.9	149.8	60	426.5	172.3	20	482.1	194.8	80	537.7	217.
341	316.2	127.7	401	371.8	150.2	461	427.4	172.7	521	483.0	195.2	581	538.6	217.
42	317.1	128.1	02	372.7	150.6	62	428.4	173.0	22	484.0	195.5	82	539.6	218.
43	318.0	128.5	03	373.7	150.9	63	429.3	173.4	23	484.9	195.9	83	540.5	218.
44	319.0	128.8	04	374.6	151.3	64	430.2	173.8	24	485.8	196.3	84	541.4	218.
45	319.9	129.2	05	375.5	151.7	65	431.1	174.2	25	486.7	196.7	85	542.4	219.
46	320.8	129.6	06	376.4	152.1	66	432.1	174.5	26	487.7	197.0	86	543.3	219.
47	321.7	130.0	07	377.4	152.4	67	433.0	174.9	27	488.6	197.4	87	544.2	219.
48	322.7	130.3	08	378.3	152.8	68	433.9	175.3	28	489.5	197.8	88	545.1	220.
49	323.6	130.7	09	379.2	153.2	69	434.8	175.7	29	490.4	198.2	89	546.1	220.
50	324.5	131.1	10	380.1	153.6	70	435.8	176.0	30	491.4	198.5	90	547.0	221.
351	325.4	131.5	411	381.1	153.9	471	436.7	176.4	531	492.3	198.9	591	547.9	221.
52	326.4	131.8	12	382.0	154.3	72	437.6	176.8	32	493.2	199.3	92	548.9	221.
53	327.3	132.2	13	382.9	154.7	73	438.6	177.2	33	494.2	199.7	93	549.8	222.
54	328.2	132.6	14	383.9	155.1	74	439.5	177.5	34	495.1	200.0	94	550.7	222.
55	329.2	133.0	15	384.8	155.4	75	440.4	177.9	35	496.0	200.4	95	551.7	222.
56	330.1	133.3	16	385.7	155.8	76	441.3	178.3	36	496.9	200.8	96	552.6	223.
57	331.0	133.7	17	386.6	156.2	77	442.3	178.7	37	497.9	201.2	97	553.5	223.
58	332.0	134.1	18	387.6	156.6	78	443.2	179.0	38	498.8	201.5	98	554.4	224.
59	332.9	134.5	19	388.5	156.9	79	444.1	179.4	39	499.7	201.9	99	555.4	224.
60	333.8	134.8	20	389.4	157.3	80	445.0	179.8	40	500.7	202.3	600	556.3	224.
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

68° (112°, 248°, 292°).

TABLE 2.

Difference of Latitude and Departure for 23° (157°, 203°, 337°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	0.9	0.4	61	56.2	23.8	121	111.4	47.3	181	166.6	70.7	241	221.8	94.2
2	1.8	0.8	62	57.1	24.2	22	112.3	47.7	82	167.5	71.1	42	222.8	94.6
3	2.8	1.2	63	58.0	24.6	23	113.2	48.1	83	168.5	71.5	43	223.7	94.9
4	3.7	1.6	64	58.9	25.0	24	114.1	48.5	84	169.4	71.9	44	224.6	95.3
5	4.6	2.0	65	59.8	25.4	25	115.1	48.8	85	170.3	72.3	45	225.5	95.7
6	5.5	2.3	66	60.8	25.8	26	116.0	49.2	86	171.2	72.7	46	226.4	96.1
7	6.4	2.7	67	61.7	26.2	27	116.9	49.6	87	172.1	73.1	47	227.4	96.5
8	7.4	3.1	68	62.6	26.6	28	117.8	50.0	88	173.1	73.5	48	228.3	96.9
9	8.3	3.5	69	63.5	27.0	29	118.7	50.4	89	174.0	73.8	49	229.2	97.3
10	9.2	3.9	70	64.4	27.4	30	119.7	50.8	90	174.9	74.2	50	230.1	97.7
11	10.1	4.3	71	65.4	27.7	131	120.6	51.2	191	175.8	74.6	251	231.0	98.1
12	11.0	4.7	72	66.3	28.1	32	121.5	51.6	92	176.7	75.0	52	232.0	98.5
13	12.0	5.1	73	67.2	28.5	33	122.4	52.0	93	177.7	75.4	53	232.9	98.9
14	12.9	5.5	74	68.1	28.9	34	123.3	52.4	94	178.6	75.8	54	233.8	99.2
15	13.8	5.9	75	69.0	29.3	35	124.3	52.7	95	179.5	76.2	55	234.7	99.6
16	14.7	6.3	76	70.0	29.7	36	125.2	53.1	96	180.4	76.6	56	235.6	100.0
17	15.6	6.6	77	70.9	30.1	37	126.1	53.5	97	181.3	77.0	57	236.6	100.4
18	16.6	7.0	78	71.8	30.5	38	127.0	53.9	98	182.3	77.4	58	237.5	100.8
19	17.5	7.4	79	72.7	30.9	39	128.0	54.3	99	183.2	77.8	59	238.4	101.2
20	18.4	7.8	80	73.6	31.3	40	128.9	54.7	200	184.1	78.1	60	239.3	101.6
21	19.3	8.2	81	74.6	31.6	141	129.8	55.1	201	185.0	78.5	261	240.3	102.0
22	20.3	8.6	82	75.5	32.0	42	130.7	55.5	02	185.9	78.9	62	241.2	102.4
23	21.2	9.0	83	76.4	32.4	43	131.6	55.9	03	186.9	79.3	63	242.1	102.8
24	22.1	9.4	84	77.3	32.8	44	132.6	56.3	04	187.8	79.7	64	243.0	103.2
25	23.0	9.8	85	78.2	33.2	45	133.5	56.7	05	188.7	80.1	65	243.9	103.5
26	23.9	10.2	86	79.2	33.6	46	134.4	57.0	06	189.6	80.5	66	244.9	103.9
27	24.9	10.5	87	80.1	34.0	47	135.3	57.4	07	190.5	80.9	67	245.8	104.3
28	25.8	10.9	88	81.0	34.4	48	136.2	57.8	08	191.5	81.3	68	246.7	104.7
29	26.7	11.3	89	81.9	34.8	49	137.2	58.2	09	192.4	81.7	69	247.6	105.1
30	27.6	11.7	90	82.8	35.2	50	138.1	58.6	10	193.3	82.1	70	248.5	105.5
31	28.5	12.1	91	83.8	35.6	151	139.0	59.0	211	194.2	82.4	271	249.5	105.9
32	29.5	12.5	92	84.7	35.9	52	139.9	59.4	12	195.1	82.8	72	250.4	106.3
33	30.4	12.9	93	85.6	36.3	53	140.8	59.8	13	196.1	83.2	73	251.3	106.7
34	31.3	13.3	94	86.5	36.7	54	141.8	60.2	14	197.0	83.6	74	252.2	107.1
35	32.2	13.7	95	87.4	37.1	55	142.7	60.6	15	197.9	84.0	75	253.1	107.5
36	33.1	14.1	96	88.4	37.5	56	143.6	61.0	16	198.8	84.4	76	254.1	107.8
37	34.1	14.5	97	89.3	37.9	57	144.5	61.3	17	199.7	84.8	77	255.0	108.2
38	35.0	14.8	98	90.2	38.3	58	145.4	61.7	18	200.7	85.2	78	255.9	108.6
39	35.9	15.2	99	91.1	38.7	59	146.4	62.1	19	201.6	85.6	79	256.8	109.0
40	36.8	15.6	100	92.1	39.1	60	147.3	62.5	20	202.5	86.0	80	257.7	109.4
41	37.7	16.0	101	93.0	39.5	161	148.2	62.9	221	203.4	86.4	281	258.7	109.8
42	38.7	16.4	02	93.9	39.9	62	149.1	63.3	22	204.4	86.7	82	259.6	110.2
43	39.6	16.8	03	94.8	40.2	63	150.0	63.7	23	205.3	87.1	83	260.5	110.6
44	40.5	17.2	04	95.7	40.6	64	151.0	64.1	24	206.2	87.5	84	261.4	111.0
45	41.4	17.6	05	96.7	41.0	65	151.9	64.5	25	207.1	87.9	85	262.3	111.4
46	42.3	18.0	06	97.6	41.4	66	152.8	64.9	26	208.0	88.3	86	263.3	111.7
47	43.3	18.4	07	98.5	41.8	67	153.7	65.3	27	209.0	88.7	87	264.2	112.1
48	44.2	18.8	08	99.4	42.2	68	154.6	65.6	28	209.9	89.1	88	265.1	112.5
49	45.1	19.1	09	100.3	42.6	69	155.6	66.0	29	210.8	89.5	89	266.0	112.9
50	46.0	19.5	10	101.3	43.0	70	156.5	66.4	30	211.7	89.9	90	266.9	113.3
51	46.9	19.9	111	102.2	43.4	171	157.4	66.8	231	212.6	90.3	291	267.9	113.7
52	47.9	20.3	12	103.1	43.8	72	158.3	67.2	32	213.6	90.6	92	268.8	114.1
53	48.8	20.7	13	104.0	44.2	73	159.2	67.6	33	214.5	91.0	93	269.7	114.5
54	49.7	21.1	14	104.9	44.5	74	160.2	68.0	34	215.4	91.4	94	270.6	114.9
55	50.6	21.5	15	105.9	44.9	75	161.1	68.4	35	216.3	91.8	95	271.5	115.3
56	51.5	21.9	16	106.8	45.3	76	162.0	68.8	36	217.2	92.2	96	272.5	115.7
57	52.5	22.3	17	107.7	45.7	77	162.9	69.2	37	218.2	92.6	97	273.4	116.0
58	53.4	22.7	18	108.6	46.1	78	163.8	69.6	38	219.1	93.0	98	274.3	116.4
59	54.3	23.1	19	109.5	46.5	79	164.8	69.9	39	220.0	93.4	99	275.2	116.8
60	55.2	23.4	20	110.5	46.9	80	165.7	70.3	40	220.9	93.8	300	276.2	117.2
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

67° (113°, 247°, 293°).

TABLE 2.

Difference of Latitude and Departure for 23° (157°, 203°, 337°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	277.1	117.6	361	332.3	141.1	421	387.5	164.5	481	442.7	188.0	541	498.0	211.4
02	278.0	118.0	62	333.2	141.5	22	388.5	164.9	82	443.7	188.4	42	498.9	211.8
03	278.9	118.4	63	334.1	141.8	23	389.4	165.3	83	444.6	188.8	43	499.8	212.2
04	279.8	118.8	64	335.1	142.2	24	390.3	165.7	84	445.5	189.2	44	500.7	212.6
05	280.8	119.2	65	336.0	142.6	25	391.2	166.1	85	446.4	189.5	45	501.7	213.0
06	281.7	119.6	66	336.9	143.0	26	392.1	166.5	86	447.3	189.9	46	502.6	213.4
07	282.6	120.0	67	337.8	143.4	27	393.1	166.8	87	448.3	190.2	47	503.5	213.8
08	283.5	120.4	68	338.7	143.8	28	394.0	167.2	88	449.2	190.6	48	504.4	214.2
09	284.4	120.8	69	339.7	144.2	29	394.9	167.6	89	450.1	191.0	49	505.3	214.6
10	285.4	121.2	70	340.6	144.6	30	395.8	168.0	90	451.0	191.4	50	506.3	215.0
311	286.3	121.6	371	341.5	145.0	431	396.7	168.4	491	451.9	191.8	551	507.2	215.3
12	287.2	121.9	72	342.4	145.4	32	397.7	168.8	92	452.9	192.2	52	508.1	215.6
13	288.1	122.3	73	343.4	145.7	33	398.6	169.2	93	453.8	192.6	53	509.0	216.0
14	289.0	122.7	74	344.3	146.1	34	399.5	169.6	94	454.7	193.0	54	509.9	216.4
15	290.0	123.1	75	345.2	146.5	35	400.4	170.0	95	455.6	193.4	55	510.9	216.8
16	290.9	123.5	76	346.1	146.9	36	401.3	170.4	96	456.6	193.8	56	511.8	217.2
17	291.8	123.9	77	3[illegible]7.0	147.3	37	402.3	170.8	97	457.5	194.2	57	512.7	217.6
18	292.7	124.3	78	348.0	147.7	38	403.2	171.1	98	458.4	194.6	58	513.6	218.0
19	293.6	124.6	79	348.9	148.1	39	404.1	171.5	99	459.3	195.0	59	514.5	218.4
20	294.6	125.0	80	349.8	148.5	40	405.0	171.9	500	460.2	195.4	60	515.5	218.8
321	295.5	125.4	381	350.7	148.9	441	405.9	172.3	501	461.2	195.8	561	516.4	219.2
22	296.4	125.8	82	351.6	149.3	42	406.9	172.7	02	462.1	196.2	62	517.3	219.6
23	297.3	126.2	83	352.6	149.7	43	407.8	173.1	03	463.0	196.6	63	518.2	220.0
24	298.2	126.6	84	353.5	150.0	44	408.7	173.5	04	463.9	197.0	64	519.2	220.4
25	299.2	127.0	85	354.4	150.4	45	409.6	173.9	05	464.9	197.4	65	520.1	220.8
26	300.1	127.4	86	355.3	150.8	46	410.5	174.3	06	465.8	197.8	66	521.0	221.2
27	301.0	127.8	87	356.2	151.2	47	411.5	174.7	07	466.7	198.1	67	521.9	221.6
28	301.9	128.2	88	357.2	151.6	48	412.4	175.1	08	467.6	198.5	68	522.8	222.0
29	302.8	128.6	89	358.1	152.0	49	413.3	175.4	09	468.5	198.8	69	523.8	222.3
30	303.8	128.9	90	359.0	152.4	50	414.2	175.8	10	469.5	199.3	70	524.7	222.7
331	304.7	129.3	391	359.9	152.8	451	415.2	176.2	511	470.4	199.7	571	525.6	223.1
32	305.6	129.7	92	360.8	153.2	52	416.1	176.6	12	471.3	200.0	72	526.5	223.4
33	306.5	130.1	93	361.8	153.6	53	417.0	177.0	13	472.2	200.4	73	527.4	223.8
34	307.5	130.5	94	362.7	154.0	54	417.9	177.4	14	473.1	200.8	74	528.4	224.2
35	308.4	130.9	95	363.6	154.3	55	418.8	177.8	15	474.0	201.2	75	529.3	224.6
36	309.3	131.3	96	364.5	154.7	56	419.8	178.2	16	475.0	201.6	76	530.2	225.0
37	310.2	131.7	97	365.4	155.1	57	420.7	178.6	17	475.9	202.0	77	531.1	225.4
38	311.1	132.1	98	366.4	155.5	58	421.6	179.0	18	476.8	202.4	78	532.0	225.8
39	312.1	132.5	99	367.3	155.9	59	422.5	179.4	19	477.7	202.8	79	533.0	226.2
40	313.0	132.9	400	368.2	156.3	60	423.4	179.7	20	478.6	203.2	80	533.9	226.6
341	313.9	133.2	401	369.1	156.7	461	424.4	180.1	521	479.6	203.6	581	534.8	227.0
42	314.8	133.6	02	370.0	157.1	62	425.3	180.5	22	480.5	204.0	82	535.7	227.4
43	315.7	134.0	03	371.0	157.5	63	426.2	180.9	23	481.4	204.4	83	536.6	227.8
44	316.7	134.4	04	371.9	157.9	64	427.1	181.3	24	482.3	204.8	84	537.6	228.2
45	317.6	134.8	05	372.8	158.3	65	428.0	181.7	25	483.2	205.2	85	538.5	228.6
46	318.5	135.2	06	373.7	158.6	66	429.0	182.1	26	484.2	205.5	86	539.4	229.0
47	319.4	135.6	07	374.6	159.0	67	429.9	182.5	27	485.1	205.9	87	540.3	229.4
48	320.3	136.0	08	375.6	159.4	68	430.8	182.9	28	486.0	206.3	88	541.2	229.8
49	321.3	136.4	09	376.5	159.8	69	431.7	183.3	29	486.9	206.7	89	542.2	230.2
50	322.2	136.8	10	377.4	160.2	70	432.6	183.7	30	487.8	207.1	90	543.1	230.6
351	323.1	137.2	411	378.3	160.6	471	433.6	184.0	531	488.8	207.4	591	544.0	231.0
52	324.0	137.5	12	379.3	161.0	72	434.5	184.4	32	489.7	207.8	92	544.9	231.3
53	324.9	137.9	13	380.2	161.4	73	435.4	184.8	33	490.6	208.2	93	545.8	231.7
54	325.9	138.3	14	381.1	161.8	74	436.3	185.2	34	491.5	208.6	94	546.8	232.0
55	326.8	138.7	15	382.0	162.2	75	437.2	185.6	35	492.5	209.0	95	547.7	232.4
56	327.7	139.1	16	382.9	162.5	76	438.2	186.0	36	493.4	209.4	96	548.6	232.8
57	328.6	139.5	17	383.9	162.9	77	439.1	186.4	37	494.3	209.8	97	549.5	233.2
58	329.5	139.9	18	384.8	163.3	78	440.0	186.8	38	495.2	210.2	98	550.4	233.6
59	330.5	140.3	19	385.7	163.7	79	440.9	187.2	39	496.1	210.6	99	551.3	234.0
60	331.4	140.7	20	386.6	164.1	80	441.8	187.6	40	497.1	211.0	600	552.3	234.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

67°(113°, 247°, 293°).

TABLE 2.

Difference of Latitude and Departure for 24° (156°, 204°, 336°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	0.9	0.4	61	55.7	24.8	121	110.5	49.2	181	165.4	73.6	241	220.2	98.0
2	1.8	0.8	62	56.6	25.2	22	111.5	49.6	82	166.3	74.0	42	221.1	98.4
3	2.7	1.2	63	57.6	25.6	23	112.4	50.0	83	167.2	74.4	43	222.0	98.8
4	3.7	1.6	64	58.5	26.0	24	113.3	50.4	84	168.1	74.8	44	222.9	99.2
5	4.6	2.0	65	59.4	26.4	25	114.2	50.8	85	169.0	75.2	45	223.8	99.7
6	5.5	2.4	66	60.3	26.8	26	115.1	51.2	86	169.9	75.7	46	224.7	100.1
7	6.4	2.8	67	61.2	27.3	27	116.0	51.7	87	170.8	76.1	47	225.6	100.5
8	7.3	3.3	68	62.1	27.7	28	116.9	52.1	88	171.7	76.5	48	226.6	100.9
9	8.2	3.7	69	63.0	28.1	29	117.8	52.5	89	172.7	76.9	49	227.5	101.3
10	9.1	4.1	70	63.9	28.5	30	118.8	52.9	90	173.6	77.3	50	228.4	101.7
11	10.0	4.5	71	64.9	28.9	131	119.7	53.3	191	174.5	77.7	251	229.3	102.1
12	11.0	4.9	72	65.8	29.3	32	120.6	53.7	92	175.4	78.1	52	230.2	102.5
13	11.9	5.3	73	66.7	29.7	33	121.5	54.1	93	176.3	78.5	53	231.1	102.9
14	12.8	5.7	74	67.6	30.1	34	122.4	54.5	94	177.2	78.9	54	232.0	103.3
15	13.7	6.1	75	68.5	30.5	35	123.3	54.9	95	178.1	79.3	55	233.0	103.7
16	14.6	6.5	76	69.4	30.9	36	124.2	55.3	96	179.1	79.7	56	233.9	104.1
17	15.5	6.9	77	70.3	31.3	37	125.2	55.7	97	180.0	80.1	57	234.8	104.5
18	16.4	7.3	78	71.3	31.7	38	126.1	56.1	98	180.9	80.5	58	235.7	104.9
19	17.4	7.7	79	72.2	32.1	39	127.0	56.5	99	181.8	80.9	59	236.6	105.3
20	18.3	8.1	80	73.1	32.5	40	127.9	56.9	200	182.7	81.3	60	237.5	105.8
21	19.2	8.5	81	74.0	32.9	141	128.8	57.3	201	183.6	81.8	261	238.4	106.2
22	20.1	8.9	82	74.9	33.4	42	129.7	57.8	02	184.5	82.2	62	239.3	106.6
23	21.0	9.4	83	75.8	33.8	43	130.6	58.2	03	185.4	82.6	63	240.3	107.0
24	21.9	9.8	84	76.7	34.2	44	131.6	58.6	04	186.4	83.0	64	241.2	107.4
25	22.8	10.2	85	77.7	34.6	45	132.5	59.0	05	187.3	83.4	65	242.1	107.8
26	23.8	10.6	86	78.6	35.0	46	133.4	59.4	06	188.2	83.8	66	243.0	108.2
27	24.7	11.0	87	79.5	35.4	47	134.3	59.8	07	189.1	84.2	67	243.9	108.6
28	25.6	11.4	88	80.4	35.8	48	135.2	60.2	08	190.0	84.6	68	244.8	109.0
29	26.5	11.8	89	81.3	36.2	49	136.1	60.6	09	190.9	85.0	69	245.7	109.4
30	27.4	12.2	90	82.2	36.6	50	137.0	61.0	10	191.8	85.4	70	246.7	109.8
31	28.3	12.6	91	83.1	37.0	151	137.9	61.4	211	192.8	85.8	271	247.6	110.2
32	29.2	13.0	92	84.0	37.4	52	138.9	61.8	12	193.7	86.2	72	248.5	110.6
33	30.1	13.4	93	85.0	37.8	53	139.8	62.2	13	194.6	86.6	73	249.4	111.0
34	31.1	13.8	94	85.9	38.2	54	140.7	62.6	14	195.5	87.0	74	250.3	111.4
35	32.0	14.2	95	86.8	38.6	55	141.6	63.0	15	196.4	87.4	75	251.2	111.9
36	32.9	14.6	96	87.7	39.0	56	142.5	63.5	16	197.3	87.9	76	252.1	112.3
37	33.8	15.0	97	88.6	39.5	57	143.4	63.9	17	198.2	88.3	77	253.1	112.7
38	34.7	15.5	98	89.5	39.9	58	144.3	64.3	18	199.2	88.7	78	254.0	113.1
39	35.6	15.9	99	90.4	40.3	59	145.3	64.7	19	200.1	89.1	79	254.9	113.5
40	36.5	16.3	100	91.4	40.7	60	146.2	65.1	20	201.0	89.5	80	255.8	113.9
41	37.5	16.7	101	92.3	41.1	161	147.1	65.5	221	201.9	89.9	281	256.7	114.3
42	38.4	17.1	02	93.2	41.5	62	148.0	65.9	22	202.8	90.3	82	257.6	114.7
43	39.3	17.5	03	94.1	41.9	63	148.9	66.3	23	203.7	90.7	83	258.5	115.1
44	40.2	17.9	04	95.0	42.3	64	149.8	66.7	24	204.6	91.1	84	259.4	115.5
45	41.1	18.3	05	95.9	42.7	65	150.7	67.1	25	205.5	91.5	85	260.4	115.9
46	42.0	18.7	06	96.8	43.1	66	151.6	67.5	26	206.5	91.9	86	261.3	116.3
47	42.9	19.1	07	97.7	43.5	67	152.6	67.9	27	207.4	92.3	87	262.2	116.7
48	43.9	19.5	08	98.7	43.9	68	153.5	68.3	28	208.3	92.7	88	263.1	117.1
49	44.8	19.9	09	99.6	44.3	69	154.4	68.7	29	209.2	93.1	89	264.0	117.5
50	45.7	20.3	10	100.5	44.7	70	155.3	69.1	30	210.1	93.5	90	264.9	118.0
51	46.6	20.7	111	101.4	45.1	171	156.2	69.6	231	211.0	94.0	291	265.8	118.4
52	47.5	21.2	12	102.3	45.6	72	157.1	70.0	32	211.9	94.4	92	266.8	118.8
53	48.4	21.6	13	103.2	46.0	73	158.0	70.4	33	212.9	94.8	93	267.7	119.2
54	49.3	22.0	14	104.1	46.4	74	159.0	70.8	34	213.8	95.2	94	268.6	119.6
55	50.2	22.4	15	105.1	46.8	75	159.9	71.2	35	214.7	95.6	95	269.5	120.0
56	51.2	22.8	16	106.0	47.2	76	160.8	71.6	36	215.6	96.0	96	270.4	120.4
57	52.1	23.2	17	106.9	47.6	77	161.7	72.0	37	216.5	96.4	97	271.3	120.8
58	53.0	23.6	18	107.8	48.0	78	162.6	72.4	38	217.4	96.8	98	272.2	121.2
59	53.9	24.0	19	108.7	48.4	79	163.5	72.8	38	218.3	97.2	99	273.2	121.6
60	54.8	24.4	20	109.6	48.8	80	164.4	73.2	40	219.3	97.6	300	274.1	122.0
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

66° (114°, 246°, 294°).

TABLE 2.

Difference of Latitude and Departure for 24° (156°, 204°, 336°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	275.0	122.4	361	329.8	146.8	421	384.6	171.2	481	439.4	195.6	541	494.2	220.0
02	275.9	122.8	62	330.7	147.2	22	385.5	171.6	82	440.3	196.0	42	495.1	220.4
03	276.8	123.2	63	331.6	147.6	23	386.4	172.1	83	441.2	196.5	43	496.0	220.9
04	277.7	123.7	64	332.5	148.1	24	387.3	172.5	84	442.1	196.9	44	496.9	221.3
05	278.6	124.1	65	333.4	148.5	25	388.2	172.9	85	443.0	197.3	45	497.8	221.7
06	279.5	124.5	66	334.3	148.9	26	389.2	173.3	86	444.0	197.7	46	498.8	222.1
07	280.4	124.9	67	335.3	149.3	27	390.1	173.7	87	444.9	198.1	47	499.7	222.5
08	281.4	125.3	68	336.2	149.7	28	391.0	174.1	88	445.8	198.5	48	500.6	222.9
09	282.3	125.7	69	337.1	150.1	29	391.9	174.5	89	446.7	198.9	49	501.5	223.3
10	283.2	126.1	70	338.0	150.5	30	392.8	174.9	90	447.6	199.3	50	502.4	223.7
311	284.1	126.5	371	338.9	150.9	431	393.7	175.3	491	448.6	199.7	551	503.4	224.1
12	285.0	126.9	72	339.8	151.3	32	394.6	175.7	92	449.5	200.1	52	504.3	224.5
13	285.9	127.3	73	340.7	151.7	33	395.6	176.1	93	450.4	200.5	53	505.2	224.9
14	286.8	127.7	74	341.7	152.1	34	396.5	176.5	94	451.3	200.9	54	506.1	225.3
15	287.8	128.1	75	342.6	152.5	35	397.4	176.9	95	452.2	201.3	55	507.0	225.7
16	288.7	128.5	76	343.5	152.9	36	398.3	177.3	96	453.1	201.7	56	507.9	226.1
17	289.6	128.9	77	344.4	153.3	37	399.2	177.7	97	454.0	202.2	57	508.8	226.6
18	290.5	129.3	78	345.3	153.7	38	400.1	178.2	98	454.9	202.6	58	509.7	227.0
19	291.4	129.8	79	346.2	154.2	39	401.0	178.6	99	455.8	203.0	59	510.6	227.4
20	292.3	130.2	80	347.1	154.6	40	402.0	179.0	500	456.8	203.4	60	511.6	227.8
321	293.2	130.6	381	348.1	155.0	441	402.9	179.4	501	457.7	203.8	561	512.5	228.2
22	294.2	131.0	82	349.0	155.4	42	403.8	179.8	02	458.6	204.2	62	513.4	228.6
23	295.1	131.4	83	349.9	155.8	43	404.7	180.2	03	459.5	204.6	63	514.3	229.0
24	296.0	131.8	84	350.8	156.2	44	405.6	180.6	04	460.4	205.0	64	515.2	229.4
25	296.9	132.2	85	351.7	156.6	45	406.5	181.0	05	461.3	205.4	65	516.1	229.8
26	297.8	132.6	86	352.6	157.0	46	407.4	181.4	06	462.2	205.8	66	517.0	230.2
27	298.7	133.0	87	353.5	157.4	47	408.3	181.8	07	463.2	206.2	67	518.0	230.6
28	299.6	133.4	88	354.4	157.8	48	409.3	182.2	08	464.1	206.6	68	518.9	231.0
29	300.5	133.8	89	355.4	158.2	49	410.2	182.6	09	465.0	207.0	69	519.8	231.4
30	301.5	134.2	90	356.3	158.6	50	411.1	183.0	10	465.9	207.4	70	520.7	231.8
331	302.4	134.6	391	357.2	159.0	451	412.0	183.4	511	466.8	207.8	571	521.6	232.2
32	303.3	135.0	92	358.1	159.4	52	412.9	183.8	12	467.7	208.2	72	522.5	232.7
33	304.2	135.4	93	359.0	159.8	53	413.8	184.3	13	468.6	208.7	73	523.4	233.1
34	305.1	135.9	94	359.9	160.3	54	414.7	184.7	14	469.5	209.1	74	524.3	233.5
35	306.0	136.3	95	360.8	160.7	55	415.7	185.1	15	470.5	209.5	75	525.3	233.9
36	306.9	136.7	96	361.8	161.1	56	416.6	185.5	16	471.4	209.9	76	526.2	234.3
37	307.9	137.1	97	362.7	161.5	57	417.5	185.9	17	472.3	210.3	77	527.1	234.7
38	308.8	137.5	98	363.6	161.9	58	418.4	186.3	18	473.2	210.7	78	528.0	235.1
39	309.7	137.9	99	364.5	162.3	59	419.3	186.7	19	474.1	211.1	79	528.9	235.5
40	310.6	138.3	400	365.4	162.7	60	420.2	187.1	20	475.0	211.5	80	529.8	235.9
341	311.5	138.7	401	366.3	163.1	461	421.1	187.5	521	475.9	211.9	581	530.8	236.3
42	312.4	139.1	02	367.2	163.5	62	422.0	187.9	22	476.8	212.3	82	531.7	236.7
43	313.3	139.5	03	368.2	163.9	63	423.0	188.3	23	477.8	212.7	83	532.6	237.1
44	314.3	139.9	04	369.1	164.3	64	423.9	188.7	24	478.7	213.1	84	533.5	237.5
45	315.2	140.3	05	370.0	164.7	65	424.8	189.1	25	479.6	213.5	85	534.4	237.9
46	316.1	140.7	06	370.9	165.1	66	425.7	189.5	26	480.5	213.9	86	535.3	238.3
47	317.0	141.1	07	371.8	165.5	67	426.6	189.9	27	481.4	214.4	87	536.2	238.8
48	317.9	141.5	08	372.7	165.9	68	427.5	190.4	28	482.3	214.8	88	537.1	239.2
49	318.8	142.0	09	373.6	166.4	69	428.4	190.8	29	483.2	215.2	89	538.0	239.6
50	319.7	142.4	10	374.5	166.8	70	429.4	191.2	30	484.2	215.6	90	539.0	240.0
351	320.6	142.8	411	375.5	167.2	471	430.3	191.6	531	485.1	216.0	591	539.9	240.4
52	321.6	143.2	12	376.4	167.6	72	431.2	192.0	32	486.0	216.4	92	540.8	240.8
53	322.5	143.6	13	377.3	168.0	73	432.1	192.4	33	486.9	216.8	93	541.7	241.2
54	323.4	144.0	14	378.2	168.4	74	433.0	192.8	34	487.8	217.2	94	542.6	241.6
55	324.3	144.4	15	379.1	168.8	75	433.9	193.2	35	488.7	217.6	95	543.5	242.0
56	325.2	144.8	16	380.0	169.2	76	434.8	193.6	36	489.6	218.0	96	544.4	242.4
57	326.1	145.2	17	380.9	169.6	77	435.8	194.0	37	490.6	218.4	97	545.4	242.8
58	327.0	145.6	18	381.9	170.0	78	436.7	194.4	38	491.5	218.8	98	546.3	243.2
59	328.0	146.0	19	382.8	170.4	79	437.6	194.8	39	492.4	219.2	99	547.2	243.6
60	328.9	146.4	20	383.7	170.8	80	438.5	195.2	40	493.3	219.6	600	548.1	244.0
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

66° (114°, 246°, 294°).

TABLE 2.

Difference of Latitude and Departure for 25° (155°, 205°, 335°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	0.9	0.4	61	55.3	25.8	121	109.7	51.1	181	164.0	76.5	241	218.4	101.9
2	1.8	0.8	62	56.2	26.2	22	110.6	51.6	82	164.9	76.9	42	219.3	102.3
3	2.7	1.3	63	57.1	26.6	23	111.5	52.0	83	165.9	77.3	43	220.2	102.7
4	3.6	1.7	64	58.0	27.0	24	112.4	52.4	84	166.8	77.8	44	221.1	103.1
5	4.5	2.1	65	58.9	27.5	25	113.3	52.8	85	167.7	78.2	45	222.0	103.5
6	5.4	2.5	66	59.8	27.9	26	114.2	53.2	86	168.6	78.6	46	223.0	104.0
7	6.3	3.0	67	60.7	28.3	27	115.1	53.7	87	169.5	79.0	47	223.9	104.4
8	7.3	3.4	68	61.6	28.7	28	116.0	54.1	88	170.4	79.5	48	224.8	104.8
9	8.2	3.8	69	62.5	29.2	29	116.9	54.5	89	171.3	79.9	49	225.7	105.2
10	9.1	4.2	70	63.4	29.6	30	117.8	54.9	90	172.2	80.3	50	226.6	105.7
11	10.0	4.6	71	64.3	30.0	131	118.7	55.4	191	173.1	80.7	251	227.5	106.1
12	10.9	5.1	72	65.3	30.4	32	119.6	55.8	92	174.0	81.1	52	228.4	106.5
13	11.8	5.5	73	66.2	30.9	33	120.5	56.2	93	174.9	81.6	53	229.3	106.9
14	12.7	5.9	74	67.1	31.3	34	121.4	56.6	94	175.8	82.0	54	230.2	107.3
15	13.6	6.3	75	68.0	31.7	35	122.4	57.1	95	176.7	82.4	55	231.1	107.8
16	14.5	6.8	76	68.9	32.1	36	123.3	57.5	96	177.6	82.8	56	232.0	108.2
17	15.4	7.2	77	69.8	32.5	37	124.2	57.9	97	178.5	83.3	57	232.9	108.6
18	16.3	7.6	78	70.7	33.0	38	125.1	58.3	98	179.4	83.7	58	233.8	109.0
19	17.2	8.0	79	71.6	33.4	39	126.0	58.7	99	180.4	84.1	59	234.7	109.5
20	18.1	8.5	80	72.5	33.8	40	126.9	59.2	200	181.3	84.5	60	235.6	109.9
21	19.0	8.9	81	73.4	34.2	141	127.8	59.6	201	182.2	84.9	261	236.5	110.3
22	19.9	9.3	82	74.3	34.7	42	128.7	60.0	02	183.1	85.4	62	237.5	110.7
23	20.8	9.7	83	75.2	35.1	43	129.6	60.4	03	184.0	85.8	63	238.4	111.1
24	21.8	10.1	84	76.1	35.5	44	130.5	60.9	04	184.9	86.2	64	239.3	111.6
25	22.7	10.6	85	77.0	35.9	45	131.4	61.3	05	185.8	86.6	65	240.2	112.0
26	23.6	11.0	86	77.9	36.3	46	132.3	61.7	06	186.7	87.1	66	241.1	112.4
27	24.5	11.4	87	78.8	36.8	47	133.2	62.1	07	187.6	87.5	67	242.0	112.8
28	25.4	11.8	88	79.8	37.2	48	134.1	62.5	08	188.5	87.9	68	242.9	113.3
29	26.3	12.3	89	80.7	37.6	49	135.0	63.0	09	189.4	88.3	69	243.8	113.7
30	27.2	12.7	90	81.6	38.0	50	135.9	63.4	10	190.3	88.7	70	244.7	114.1
31	28.1	13.1	91	82.5	38.5	151	136.9	63.8	211	191.2	89.2	271	245.6	114.5
32	29.0	13.5	92	83.4	38.9	52	137.8	64.2	12	192.1	89.6	72	246.5	115.0
33	29.9	13.9	93	84.3	39.3	53	138.7	64.7	13	193.0	90.0	73	247.4	115.4
34	30.8	14.4	94	85.2	39.7	54	139.6	65.1	14	193.9	90.4	74	248.3	115.8
35	31.7	14.8	95	86.1	40.1	55	140.5	65.5	15	194.9	90.9	75	249.2	116.2
36	32.6	15.2	96	87.0	40.6	56	141.4	65.9	16	195.8	91.3	76	250.1	116.6
37	33.5	15.6	97	87.9	41.0	57	142.3	66.4	17	196.7	91.7	77	251.0	117.1
38	34.4	16.1	98	88.8	41.4	58	143.2	66.8	18	197.6	92.1	78	252.0	117.5
39	35.3	16.5	99	89.7	41.8	59	144.1	67.2	19	198.5	92.6	79	252.9	117.9
40	36.3	16.9	100	90.6	42.3	60	145.0	67.6	20	199.4	93.0	80	253.8	118.3
41	37.2	17.3	101	91.5	42.7	161	145.9	68.0	221	200.3	93.4	281	254.7	118.8
42	38.1	17.7	02	92.4	43.1	62	146.8	68.5	22	201.2	93.8	82	255.6	119.2
43	39.0	18.2	03	93.3	43.5	63	147.7	68.9	23	202.1	94.2	83	256.5	119.6
44	39.9	18.6	04	94.3	44.0	64	148.6	69.3	24	203.0	94.7	84	257.4	120.0
45	40.8	19.0	05	95.2	44.4	65	149.5	69.7	25	203.9	95.1	85	258.3	120.4
46	41.7	19.4	06	96.1	44.8	66	150.4	70.2	26	204.8	95.5	86	259.2	120.9
47	42.6	19.9	07	97.0	45.2	67	151.4	70.6	27	205.7	95.9	87	260.1	121.3
48	43.5	20.3	08	97.9	45.6	68	152.3	71.0	28	206.6	96.4	88	261.0	121.7
49	44.4	20.7	09	98.8	46.1	69	153.2	71.4	29	207.5	96.8	89	261.9	122.1
50	45.3	21.1	10	99.7	46.5	70	154.1	71.8	30	208.5	97.2	90	262.8	122.6
51	46.2	21.6	111	100.6	46.9	171	155.0	72.3	231	209.4	97.6	291	263.7	123.0
52	47.1	22.0	12	101.5	47.3	72	155.9	72.7	32	210.3	98.0	92	264.6	123.4
53	48.0	22.4	13	102.4	47.8	73	156.8	73.1	33	211.2	98.5	93	265.5	123.8
54	48.9	22.8	14	103.3	48.2	74	157.7	73.5	34	212.1	98.9	94	266.5	124.2
55	49.8	23.2	15	104.2	48.6	75	158.6	74.0	35	213.0	99.3	95	267.4	124.7
56	50.8	23.7	16	105.1	49.0	76	159.5	74.4	36	213.9	99.7	96	268.3	125.1
57	51.7	24.1	17	106.0	49.4	77	160.4	74.8	37	214.8	100.2	97	269.2	125.5
58	52.6	24.5	18	106.9	49.9	78	161.3	75.2	38	215.7	100.6	98	270.1	125.9
59	53.5	24.9	19	107.9	50.3	79	162.2	75.6	39	216.6	101.0	99	271.0	126.4
60	54.4	25.4	20	108.8	50.7	80	163.1	76.1	40	217.5	101.4	300	271.9	126.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

65° (115°, 245°, 295°).

TABLE 2.

Difference of Latitude and Departure for 25° (155°, 205°, 335°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	272.8	127.2	361	327.1	152.5	421	381.5	177.9	481	435.9	203.3	541	490.3	228.6
02	273.7	127.6	62	328.0	153.0	22	382.4	178.3	82	436.8	203.7	42	491.2	229.0
03	274.6	128.0	63	329.0	153.4	23	383.3	178.7	83	437.7	204.1	43	492.1	229.4
04	275.5	128.4	64	329.9	153.8	24	384.2	179.2	84	438.6	204.5	44	493.0	229.9
05	276.4	128.9	65	330.8	154.2	25	385.1	179.6	85	439.5	204.9	45	493.9	230.3
06	277.3	129.3	66	331.7	154.6	26	386.0	180.0	86	440.4	205.4	46	494.8	230.7
07	278.2	129.7	67	332.6	155.1	27	387.0	180.4	87	441.3	205.8	47	495.7	231.1
08	279.1	130.1	68	333.5	155.5	28	387.9	180.9	88	442.2	206.2	48	496.6	231.6
09	280.0	130.6	69	334.4	155.9	29	388.8	181.3	89	443.1	206.6	49	497.5	232.0
10	280.9	131.0	70	335.3	156.3	30	389.7	181.7	90	444.0	207.1	50	498.4	232.4
311	281.8	131.4	371	336.2	156.8	431	390.6	182.1	491	444.9	207.5	551	499.3	232.8
12	282.7	131.8	72	337.1	157.2	32	391.5	182.5	92	445.9	207.9	52	500.2	233.2
13	283.6	132.2	73	338.0	157.6	33	392.4	183.0	93	446.8	208.3	53	501.1	233.7
14	284.5	132.7	74	338.9	158.0	34	393.3	183.4	94	447.7	208.7	54	502.0	234.1
15	285.4	133.1	75	339.8	158.5	35	394.2	183.8	95	448.6	209.1	55	503.0	234.5
16	286.4	133.5	76	340.7	158.9	36	395.1	184.2	96	449.5	209.6	56	503.9	235.0
17	287.3	133.9	77	341.6	159.3	37	396.0	184.7	97	450.4	210.0	57	504.8	235.4
18	288.2	134.4	78	342.5	159.7	38	396.9	185.1	98	451.3	210.4	58	505.7	235.8
19	289.1	134.8	79	343.5	160.1	39	397.8	185.5	99	452.2	210.9	59	506.6	236.2
20	290.0	135.2	80	344.4	160.6	40	398.7	185.9	500	453.1	211.3	60	507.5	236.6
321	290.9	135.6	381	345.3	161.0	441	399.6	186.3	501	454.0	211.7	561	508.4	237.1
22	291.8	136.1	82	346.2	161.4	42	400.6	186.8	02	454.9	212.1	62	509.3	237.5
23	292.7	136.5	83	347.1	161.8	43	401.5	187.2	03	455.8	212.5	63	510.2	237.9
24	293.6	136.9	84	348.0	162.3	44	402.4	187.6	04	456.7	213.0	64	511.1	238.3
25	294.5	137.3	85	348.9	162.7	45	403.3	188.0	05	457.7	213.4	65	512.0	238.7
26	295.4	137.7	86	349.8	163.1	46	404.2	188.5	06	458.6	213.8	66	512.9	239.2
27	296.3	138.2	87	350.7	163.5	47	405.1	188.9	07	459.5	214.2	67	513.8	239.6
28	297.2	138.6	88	351.6	163.9	48	406.0	189.3	08	460.4	214.7	68	514.8	240.1
29	298.1	139.0	89	352.5	164.4	49	406.9	189.7	09	461.3	215.1	69	515.7	240.5
30	299.0	139.4	90	353.4	164.8	50	407.8	190.1	10	462.2	215.5	70	516.6	240.9
331	300.0	139.9	391	354.3	165.2	451	408.7	190.6	511	463.1	215.9	571	517.5	241.3
32	300.9	140.3	92	355.2	165.6	52	409.6	191.0	12	464.0	216.4	72	518.4	241.7
33	301.8	140.7	93	356.1	166.1	53	410.5	191.4	13	464.9	216.8	73	519.3	242.1
34	302.7	141.1	94	357.0	166.5	54	411.4	191.8	14	465.8	217.2	74	520.2	242.6
35	303.6	141.5	95	358.0	166.9	55	412.3	192.3	15	466.7	217.7	75	521.1	243.0
36	304.5	142.0	96	358.9	167.3	56	413.2	192.7	16	467.6	218.1	76	522.0	243.4
37	305.4	142.4	97	359.8	167.7	57	414.1	193.1	17	468.5	218.5	77	522.9	243.8
38	306.3	142.8	98	360.7	168.2	58	415.1	193.5	18	469.4	218.9	78	523.8	244.3
39	307.2	143.2	99	361.6	168.6	59	416.0	194.0	19	470.3	219.3	79	524.7	244.7
40	308.1	143.7	400	362.5	169.0	60	416.9	194.4	20	471.2	219.8	80	525.6	245.1
341	309.0	144.1	401	363.4	169.4	461	417.8	194.8	521	472.2	220.2	581	526.5	245.5
42	309.9	144.5	02	364.3	169.9	62	418.7	195.2	22	473.1	220.6	82	527.4	246.0
43	310.8	144.9	03	365.2	170.3	63	419.6	195.6	23	474.0	221.0	83	528.3	246.4
44	311.7	145.4	04	366.1	170.7	64	420.5	196.1	24	474.9	221.4	84	529.3	246.8
45	312.6	145.8	05	367.0	171.1	65	421.4	196.5	25	475.8	221.9	85	530.2	247.2
46	313.5	146.2	06	367.9	171.6	66	422.3	196.9	26	476.7	222.3	86	531.1	247.7
47	314.5	146.6	07	368.8	172.0	67	423.2	197.3	27	477.6	222.7	87	532.0	248.1
48	315.4	147.0	08	369.7	172.4	68	424.1	197.8	28	478.5	223.2	88	532.9	248.5
49	316.3	147.5	09	370.6	172.8	69	425.0	198.2	29	479.4	223.6	89	533.8	248.9
50	317.2	147.9	10	371.5	173.2	70	425.9	198.6	30	480.3	224.0	90	534.7	249.4
351	318.1	148.3	411	372.5	173.7	471	426.8	199.0	531	481.2	224.4	591	535.6	249.8
52	319.0	148.7	12	373.4	174.1	72	427.7	199.4	32	482.1	224.8	92	536.5	250.2
53	319.9	149.2	13	374.3	174.5	73	428.6	199.9	33	483.0	225.3	93	537.4	250.6
54	320.8	149.6	14	375.2	174.9	74	429.6	200.3	34	483.9	225.7	94	538.3	251.1
55	321.7	150.0	15	376.1	175.4	75	430.5	200.7	35	484.8	226.1	95	539.2	251.5
56	322.6	150.4	16	377.0	175.8	76	431.4	201.1	36	485.7	226.5	96	540.1	251.9
57	323.5	150.8	17	377.9	176.2	77	432.3	201.6	37	486.7	226.9	97	541.0	252.3
58	324.4	151.3	18	378.8	176.6	78	433.2	202.0	38	487.6	227.4	98	541.9	252.7
59	325.3	151.7	19	379.7	177.0	79	434.1	202.4	39	488.5	227.8	99	542.8	253.1
60	326.2	152.1	20	380.6	177.5	80	435.0	202.8	40	489.4	228.2	600	543.8	253.6
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

65° (115°, 245°, 295°).

TABLE 2.

Difference of Latitude and Departure for 26° (154°, 206°, 334°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	0.9	0.4	61	54.8	26.7	121	108.8	53.0	181	162.7	79.3	241	216.6	105.6
2	1.8	0.9	62	55.7	27.2	22	109.7	53.5	82	163.6	79.8	42	217.5	106.1
3	2.7	1.3	63	56.6	27.6	23	110.6	53.9	83	164.5	80.2	43	218.4	106.5
4	3.6	1.8	64	57.5	28.1	24	111.5	54.4	84	165.4	80.7	44	219.3	107.0
5	4.5	2.2	65	58.4	28.5	25	112.3	54.8	85	166.3	81.1	45	220.2	107.4
6	5.4	2.6	66	59.3	28.9	26	113.2	55.2	86	167.2	81.5	46	221.1	107.8
7	6.3	3.1	67	60.2	29.4	27	114.1	55.7	87	168.1	82.0	47	222.0	108.3
8	7.2	3.5	68	61.1	29.8	28	115.0	56.1	88	169.0	82.4	48	222.9	108.7
9	8.1	3.9	69	62.0	30.2	29	115.9	56.5	89	169.9	82.9	49	223.8	109.2
10	9.0	4.4	70	62.9	30.7	30	116.8	57.0	90	170.8	83.3	50	224.7	109.6
11	9.9	4.8	71	63.8	31.1	131	117.7	57.4	191	171.7	83.7	251	225.6	110.0
12	10.8	5.3	72	64.7	31.6	32	118.6	57.9	92	172.6	84.2	52	226.5	110.5
13	11.7	5.7	73	65.6	32.0	33	119.5	58.3	93	173.5	84.6	53	227.4	110.9
14	12.6	6.1	74	66.5	32.4	34	120.4	58.7	94	174.4	85.0	54	228.3	111.3
15	13.5	6.6	75	67.4	32.9	35	121.3	59.2	95	175.3	85.5	55	229.2	111.8
16	14.4	7.0	76	68.3	33.3	36	122.2	59.6	96	176.2	85.9	56	230.1	112.2
17	15.3	7.5	77	69.2	33.8	37	123.1	60.1	97	177.1	86.4	57	231.0	112.7
18	16.2	7.9	78	70.1	34.2	38	124.0	60.5	98	178.0	86.8	58	231.9	113.1
19	17.1	8.3	79	71.0	34.6	39	124.9	60.9	99	178.9	87.2	59	232.8	113.5
20	18.0	8.8	80	71.9	35.1	40	125.8	61.4	200	179.8	87.7	60	233.7	114.0
21	18.9	9.2	81	72.8	35.5	141	126.7	61.8	201	180.7	88.1	261	234.6	114.4
22	19.8	9.6	82	73.7	35.9	42	127.6	62.2	02	181.6	88.6	62	235.5	114.9
23	20.7	10.1	83	74.6	36.4	43	128.5	62.7	03	182.5	89.0	63	236.4	115.3
24	21.6	10.5	84	75.5	36.8	44	129.4	63.1	04	183.4	89.4	64	237.3	115.7
25	22.5	11.0	85	76.4	37.3	45	130.3	63.6	05	184.3	89.9	65	238.2	116.2
26	23.4	11.4	86	77.3	37.7	46	131.2	64.0	06	185.2	90.3	66	239.1	116.6
27	24.3	11.8	87	78.2	38.1	47	132.1	64.4	07	186.1	90.7	67	240.0	117.0
28	25.2	12.3	88	79.1	38.6	48	133.0	64.9	08	186.9	91.2	68	240.9	117.5
29	26.1	12.7	89	80.0	39.0	49	133.9	65.3	09	187.8	91.6	69	241.8	117.9
30	27.0	13.2	90	80.9	39.5	50	134.8	65.8	10	188.7	92.1	70	242.7	118.4
31	27.9	13.6	91	81.8	39.9	151	135.7	66.2	211	189.6	92.5	271	243.6	118.8
32	28.8	14.0	92	82.7	40.3	52	136.6	66.6	12	190.5	92.9	72	244.5	119.2
33	29.7	14.5	93	83.6	40.8	53	137.5	67.1	13	191.4	93.4	73	245.4	119.7
34	30.6	14.9	94	84.5	41.2	54	138.4	67.5	14	192.3	93.8	74	246.3	120.1
35	31.5	15.3	95	85.4	41.6	55	139.3	67.9	15	193.2	94.2	75	247.2	120.6
36	32.4	15.8	96	86.3	42.1	56	140.2	68.4	16	194.1	94.7	76	248.1	121.0
37	33.3	16.2	97	87.2	42.5	57	141.1	68.8	17	195.0	95.1	77	249.0	121.4
38	34.2	16.7	98	88.1	43.0	58	142.0	69.3	18	195.9	95.6	78	249.9	121.9
39	35.1	17.1	99	89.0	43.4	59	142.9	69.7	19	196.8	96.0	79	250.8	122.3
40	36.0	17.5	100	89.9	43.8	60	143.8	70.1	20	197.7	96.4	80	251.7	122.7
41	36.9	18.0	101	90.8	44.3	161	144.7	70.6	221	198.6	96.9	281	252.6	123.2
42	37.7	18.4	02	91.7	44.7	62	145.6	71.0	22	199.5	97.3	82	253.5	123.6
43	38.6	18.8	03	92.6	45.2	63	146.5	71.5	23	200.4	97.8	83	254.4	124.1
44	39.5	19.3	04	93.5	45.6	64	147.4	71.9	24	201.3	98.2	84	255.3	124.5
45	40.4	19.7	05	94.4	46.0	65	148.3	72.3	25	202.2	98.6	85	256.2	124.9
46	41.3	20.2	06	95.3	46.5	66	149.2	72.8	26	203.1	99.1	86	257.1	125.4
47	42.2	20.6	07	96.2	46.9	67	150.1	73.2	27	204.0	99.5	87	258.0	125.8
48	43.1	21.0	08	97.1	47.3	68	151.0	73.6	28	204.9	99.9	88	258.9	126.3
49	44.0	21.5	09	98.0	47.8	69	151.9	74.1	29	205.8	100.4	89	259.8	126.7
50	44.9	21.9	10	98.9	48.2	70	152.8	74.5	30	206.7	100.8	90	260.7	127.1
51	45.8	22.4	111	99.8	48.7	171	153.7	75.0	231	207.6	101.3	291	261.5	127.6
52	46.7	22.8	12	100.7	49.1	72	154.6	75.4	32	208.5	101.7	92	262.4	128.0
53	47.6	23.2	13	101.6	49.5	73	155.5	75.8	33	209.4	102.1	93	263.3	128.4
54	48.5	23.7	14	102.5	50.0	74	156.4	76.3	34	210.3	102.6	94	264.2	128.9
55	49.4	24.1	15	103.4	50.4	75	157.3	76.7	35	211.2	103.0	95	265.1	129.3
56	50.3	24.5	16	104.3	50.9	76	158.2	77.2	36	212.1	103.5	96	266.0	129.8
57	51.2	25.0	17	105.2	51.3	77	159.1	77.6	37	213.0	103.9	97	266.9	130.2
58	52.1	25.4	18	106.1	51.7	78	160.0	78.0	38	213.9	104.3	98	267.8	130.6
59	53.0	25.9	19	107.0	52.2	79	160.9	78.5	39	214.8	104.8	99	268.7	131.1
60	53.9	26.3	20	107.9	52.6	80	161.8	78.9	40	215.7	105.2	300	269.6	131.5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

64° (116°, 244°, 296°).

TABLE 2.

Difference of Latitude and Departure for 26° (154°, 206°, 334).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	270.5	132.0	361	324.5	158.3	421	378.4	184.6	481	432.3	210.9	541	486.2	237.2
02	271.4	132.4	62	325.4	158.7	22	379.3	185.0	82	433.2	211.3	42	487.1	237.6
03	272.3	132.8	63	326.3	159.1	23	380.2	185.4	83	434.1	211.7	43	488.0	238.0
04	273.2	133.3	64	327.2	159.6	24	381.1	185.9	84	435.0	212.2	44	488.9	238.5
05	274.1	133.7	65	328.1	160.0	25	382.0	186.3	85	435.9	212.6	45	489.8	238.9
06	275.0	134.1	66	329.0	160.4	26	382.9	186.7	86	436.8	213.0	46	490.7	239.3
07	275.9	134.6	67	329.9	160.9	27	383.8	187.2	87	437.7	213.5	47	491.6	239.8
08	276.8	135.0	68	330.8	161.3	28	384.7	187.6	88	438.6	213.9	48	492.5	240.2
09	277.7	135.5	69	331.7	161.8	29	385.6	188.1	89	439.5	214.4	49	493.4	240.7
10	278.6	135.9	70	332.6	162.2	30	386.5	188.5	90	440.4	214.8	50	494.3	241.1
311	279.5	136.3	371	333.5	162.6	431	387.4	188.9	491	441.3	215.2	551	495.2	241.5
12	280.4	136.8	72	334.4	163.1	32	388.3	189.4	92	442.2	215.7	52	496.1	242.0
13	281.3	137.2	73	335.3	163.5	33	389.2	189.8	93	443.1	216.1	53	497.0	242.4
14	282.2	137.7	74	336.2	164.0	34	390.1	190.3	94	444.0	216.6	54	497.9	242.9
15	283.1	138.1	75	337.1	164.4	35	391.0	190.7	95	444.9	217.0	55	498.8	243.3
16	284.0	138.5	76	338.0	164.8	36	391.9	191.1	96	445.8	217.4	56	499.7	243.7
17	284.9	139.0	77	338.9	165.3	37	392.8	191.6	97	446.7	217.9	57	500.6	244.2
18	285.8	139.4	78	339.8	165.7	38	393.7	192.0	98	447.6	218.3	58	501.5	244.6
19	286.7	139.8	79	340.7	166.2	39	394.6	192.4	99	448.5	218.7	59	502.4	245.0
20	287.6	140.3	80	341.5	166.6	40	395.5	192.9	500	449.4	219.2	60	503.3	245.5
321	288.5	140.7	381	342.4	167.0	441	396.4	193.3	501	450.3	219.6	561	504.2	245.9
22	289.4	141.2	82	343.3	167.5	42	397.3	193.8	02	451.2	220.1	62	505.1	246.4
23	290.3	141.6	83	344.2	167.9	43	398.2	194.2	03	452.1	220.5	63	506.0	246.8
24	291.2	142.0	84	345.1	168.3	44	399.1	194.7	04	453.0	221.0	64	506.9	247.3
25	292.1	142.5	85	346.0	168.8	45	400.0	195.1	05	453.9	221.4	65	507.8	247.7
26	293.0	142.9	86	346.9	169.2	46	400.9	195.5	06	454.8	221.8	66	508.7	248.1
27	293.9	143.4	87	347.8	169.7	47	401.8	196.0	07	455.7	222.3	67	509.6	248.6
28	294.8	143.8	88	348.7	170.1	48	402.7	196.4	08	456.6	222.7	68	510.5	249.0
29	295.7	144.2	89	349.6	170.5	49	403.6	196.8	09	457.5	223.1	69	511.4	249.4
30	296.6	144.7	90	350.5	171.0	50	404.5	197.3	10	458.4	223.6	70	512.3	249.9
331	297.5	145.1	391	351.4	171.4	451	405.4	197.7	511	459.3	224.0	571	513.2	250.3
32	298.4	145.6	92	352.3	171.8	52	406.3	198.1	12	460.2	224.4	72	514.1	250.8
33	299.3	146.0	93	353.2	172.3	53	407.2	198.6	13	461.1	224.9	73	515.0	251.2
34	300.2	146.4	94	354.1	172.7	54	408.1	199.0	14	462.0	225.3	74	515.9	251.6
35	301.1	146.9	95	355.0	173.2	55	409.0	199.5	15	462.9	225.8	75	516.8	252.1
36	302.0	147.3	96	355.9	173.6	56	409.9	199.9	16	463.8	226.2	76	517.7	252.5
37	302.9	147.7	97	356.8	174.0	57	410.8	200.3	17	464.7	226.6	77	518.6	252.9
38	303.8	148.2	98	357.7	174.5	58	411.7	200.8	18	465.6	227.1	78	519.5	253.4
39	304.7	148.6	99	358.6	174.9	59	412.6	201.2	19	466.5	227.5	79	520.4	253.8
40	305.6	149.0	400	359.5	175.4	60	413.5	201.7	20	467.4	228.0	80	521.3	254.3
341	306.5	149.5	401	360.4	175.8	461	414.4	202.1	521	468.3	228.4	581	522.2	254.7
42	307.4	149.9	02	361.3	176.2	62	415.2	202.5	22	469.2	228.8	82	523.1	255.1
43	308.3	150.4	03	362.2	176.7	63	416.1	203.0	23	470.1	229.3	83	524.0	255.6
44	309.2	150.8	04	363.1	177.1	64	417.0	203.4	24	471.0	229.7	84	524.9	256.0
45	310.1	151.2	05	364.0	177.5	65	417.9	203.8	25	471.9	230.1	85	525.8	256.4
46	311.0	151.7	06	364.9	178.0	66	418.8	204.3	26	472.8	230.6	86	526.7	256.9
47	311.9	152.1	07	365.8	178.4	67	419.7	204.7	27	473.7	231.0	87	527.6	257.3
48	312.8	152.6	08	366.7	178.9	68	420.6	205.2	28	474.6	231.5	88	528.5	257.8
49	313.7	153.0	09	367.6	179.3	69	421.5	205.6	29	475.5	231.9	89	529.4	258.2
50	314.6	153.4	10	368.5	179.7	70	422.4	206.0	30	476.4	232.3	90	530.3	258.6
351	315.5	153.9	411	369.4	180.2	471	423.3	206.5	531	477.3	232.8	591	531.2	259.1
52	316.4	154.3	12	370.3	180.6	72	424.2	206.9	32	478.2	233.2	92	532.1	259.5
53	317.3	154.7	13	371.2	181.1	73	425.1	207.3	33	479.1	233.6	93	533.0	259.9
54	318.2	155.2	14	372.1	181.5	74	426.0	207.8	34	480.0	234.1	94	533.9	260.4
55	319.1	155.6	15	373.0	181.9	75	426.9	208.2	35	480.9	234.5	95	534.8	260.8
56	320.0	156.1	16	373.9	182.4	76	427.8	208.7	36	481.8	235.0	96	535.7	261.3
57	320.9	156.5	17	374.8	182.8	77	428.7	209.1	37	482.7	235.4	97	536.6	261.7
58	321.8	156.9	18	375.7	183.2	78	429.6	209.5	38	483.6	235.8	98	537.5	262.1
59	322.7	157.4	19	376.6	183.7	79	430.5	210.0	39	484.5	236.3	90	538.4	262.6
60	323.6	157.8	20	377.5	184.1	80	431.4	210.4	40	485.3	236.7	600	539.3	263.0
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

64° (116°, 244°, 296°).

TABLE 2.

Difference of Latitude and Departure for 27° (153°, 207°, 333°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	0.9	0.5	61	54.4	27.7	121	107.8	54.9	181	161.3	82.2	241	214.7	109.4
2	1.8	0.9	62	55.2	28.1	22	108.7	55.4	82	162.2	82.6	42	215.6	109.9
3	2.7	1.4	63	56.1	28.6	23	109.6	55.8	83	163.1	83.1	43	216.5	110.3
4	3.6	1.8	64	57.0	29.1	24	110.5	56.3	84	163.9	83.5	44	217.4	110.8
5	4.5	2.3	65	57.9	29.5	25	111.4	56.7	85	164.8	84.0	45	218.3	111.2
6	5.3	2.7	66	58.8	30.0	26	112.3	57.2	86	165.7	84.4	46	219.2	111.7
7	6.2	3.2	67	59.7	30.4	27	113.2	57.7	87	166.6	84.9	47	220.1	112.1
8	7.1	3.6	68	60.6	30.9	28	114.0	58.1	88	167.5	85.4	48	221.0	112.6
9	8.0	4.1	69	61.5	31.3	29	114.9	58.6	89	168.4	85.8	49	221.9	113.0
10	8.9	4.5	70	62.4	31.8	30	115.8	59.0	90	169.3	86.3	50	222.8	113.5
11	9.8	5.0	71	63.3	32.2	131	116.7	59.5	191	170.2	86.7	251	223.6	114.0
12	10.7	5.4	72	64.2	32.7	32	117.6	59.9	92	171.1	87.2	52	224.5	114.4
13	11.6	5.9	73	65.0	33.1	33	118.5	60.4	93	172.0	87.6	53	225.4	114.9
14	12.5	6.4	74	65.9	33.6	34	119.4	60.8	94	172.9	88.1	54	226.3	115.3
15	13.4	6.8	75	66.8	34.0	35	120.3	61.3	95	173.7	88.5	55	227.2	115.8
16	14.3	7.3	76	67.7	34.5	36	121.2	61.7	96	174.6	89.0	56	228.1	116.2
17	15.1	7.7	77	68.6	35.0	37	122.1	62.2	97	175.5	89.4	57	229.0	116.7
18	16.0	8.2	78	69.5	35.4	38	123.0	62.7	98	176.4	89.9	58	229.9	117.1
19	16.9	8.6	79	70.4	35.9	39	123.8	63.1	99	177.3	90.3	59	230.8	117.6
20	17.8	9.1	80	71.3	36.3	40	124.7	63.6	200	178.2	90.8	60	231.7	118.0
21	18.7	9.5	81	72.2	36.8	141	125.6	64.0	201	179.1	91.3	261	232.6	118.5
22	19.6	10.0	82	73.1	37.2	42	126.5	64.5	02	180.0	91.7	62	233.4	118.9
23	20.5	10.4	83	74.0	37.7	43	127.4	64.9	03	180.9	92.2	63	234.3	119.4
24	21.4	10.9	84	74.8	38.1	44	128.3	65.4	04	181.8	92.6	64	235.2	119.9
25	22.3	11.3	85	75.7	38.6	45	129.2	65.8	05	182.7	93.1	65	236.1	120.3
26	23.2	11.8	86	76.6	39.0	46	130.1	66.3	06	183.5	93.5	66	237.0	120.8
27	24.1	12.3	87	77.5	39.5	47	131.0	66.7	07	184.4	94.0	67	237.9	121.2
28	24.9	12.7	88	78.4	40.0	48	131.9	67.2	08	185.3	94.4	68	238.8	121.7
29	25.8	13.2	89	79.3	40.4	49	132.8	67.6	09	186.2	94.9	69	239.7	122.1
30	26.7	13.6	90	80.2	40.9	50	133.7	68.1	10	187.1	95.3	70	240.6	122.6
31	27.6	14.1	91	81.1	41.3	151	134.5	68.6	211	188.0	95.8	271	241.5	123.0
32	28.5	14.5	92	82.0	41.8	52	135.4	69.0	12	188.9	96.2	72	242.4	123.5
33	29.4	15.0	93	82.9	42.2	53	136.3	69.5	13	189.8	96.7	73	243.2	123.9
34	30.3	15.4	94	83.8	42.7	54	137.2	69.9	14	190.7	97.2	74	244.1	124.4
35	31.2	15.9	95	84.6	43.1	55	138.1	70.4	15	191.6	97.6	75	245.0	124.8
36	32.1	16.3	96	85.5	43.6	56	139.0	70.8	16	192.5	98.1	76	245.9	125.3
37	33.0	16.8	97	86.4	44.0	57	139.9	71.3	17	193.3	98.5	77	246.8	125.8
38	33.9	17.3	98	87.3	44.5	58	140.8	71.7	18	194.2	99.0	78	247.7	126.2
39	34.7	17.7	99	88.2	44.9	59	141.7	72.2	19	195.1	99.4	79	248.6	126.7
40	35.6	18.2	100	89.1	45.4	60	142.6	72.6	20	196.0	99.9	80	249.5	127.1
41	36.5	18.6	101	90.0	45.9	161	143.5	73.1	221	196.9	100.3	281	250.4	127.6
42	37.4	19.1	02	90.9	46.3	62	144.3	73.5	22	197.8	100.8	82	251.3	128.0
43	38.3	19.5	03	91.8	46.8	63	145.2	74.0	23	198.7	101.2	83	252.2	128.5
44	39.2	20.0	04	92.7	47.2	64	146.1	74.5	24	199.6	101.7	84	253.0	128.9
45	40.1	20.4	05	93.6	47.7	65	147.0	74.9	25	200.5	102.1	85	253.9	129.4
46	41.0	20.9	06	94.4	48.1	66	147.9	75.4	26	201.4	102.6	86	254.8	129.8
47	41.9	21.3	07	95.3	48.6	67	148.8	75.8	27	202.3	103.1	87	255.7	130.3
48	42.8	21.8	08	96.2	49.0	68	149.7	76.3	28	203.1	103.5	88	256.6	130.7
49	43.7	22.2	09	97.1	49.5	69	150.6	76.7	29	204.0	104.0	89	257.5	131.2
50	44.6	22.7	10	98.0	49.9	70	151.5	77.2	30	204.9	104.4	90	258.4	131.7
51	45.4	23.2	111	98.9	50.4	171	152.4	77.6	231	205.8	104.9	291	259.3	132.1
52	46.3	23.6	12	99.8	50.8	72	153.3	78.1	32	206.7	105.3	92	260.2	132.6
53	47.2	24.1	13	100.7	51.3	73	154.1	78.5	33	207.6	105.8	93	261.1	133.0
54	48.1	24.5	14	101.6	51.8	74	155.0	79.0	34	208.5	106.2	94	262.0	133.5
55	49.0	25.0	15	102.5	52.2	75	155.9	79.4	35	209.4	106.7	95	262.8	133.9
56	49.9	25.4	16	103.4	52.7	76	156.8	79.9	36	210.3	107.1	96	263.7	134.4
57	50.8	25.9	17	104.2	53.1	77	157.7	80.4	37	211.2	107.6	97	264.6	134.8
58	51.7	26.3	18	105.1	53.6	78	158.6	80.8	38	212.1	108.0	98	265.5	135.3
59	52.6	26.8	19	106.0	54.0	79	159.5	81.3	39	213.0	108.5	99	266.4	135.7
60	53.5	27.2	20	106.9	54.5	80	160.4	81.7	40	213.8	109.0	300	267.3	136.2
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

63° (117°, 243°, 297°).

TABLE 2.

Difference of Latitude and Departure for 27° (153°, 207°, 333°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	268.2	136.7	361	321.7	163.9	421	375.1	191.1	481	428.6	218.3	541	482.0	245.6
02	269.1	137.1	62	322.5	164.4	22	376.0	191.6	82	429.4	218.8	42	482.9	246.1
03	270.0	137.6	63	323.4	164.8	23	376.9	192.0	83	430.3	219.2	43	483.8	246.5
04	270.9	138.0	64	324.3	165.3	24	377.8	192.5	84	431.2	219.7	44	484.7	247.0
05	271.8	138.5	65	325.2	165.7	25	378.7	193.0	85	432.1	220.1	45	485.6	247.4
06	272.7	138.9	66	326.1	166.2	26	379.6	193.4	86	433.0	220.6	46	486.4	247.9
07	273.5	139.4	67	327.0	166.6	27	380.5	193.9	87	433.9	221.1	47	487.3	248.4
08	274.4	139.8	68	327.9	167.1	28	381.4	194.3	88	434.8	221.5	48	488.2	248.8
09	275.3	140.3	69	328.8	167.5	29	382.2	194.8	89	435.7	222.0	49	489.1	249.2
10	276.2	140.7	70	329.7	168.0	30	383.1	195.2	90	436.6	222.4	50	490.0	249.7
311	277.1	141.2	371	330.6	168.4	431	384.0	195.7	491	437.5	222.9	551	490.9	250.1
12	278.0	141.7	72	331.5	168.9	32	384.9	196.1	92	438.3	223.3	52	491.8	250.6
13	278.9	142.1	73	332.3	169.3	33	385.8	196.6	93	439.2	223.8	53	492.7	251.0
14	279.8	142.6	74	333.2	169.8	34	386.7	197.0	94	440.1	224.2	54	493.6	251.5
15	280.7	143.0	75	334.1	170.3	35	387.6	197.5	95	441.0	224.7	55	494.5	252.0
16	281.6	143.5	76	335.0	170.7	36	388.5	197.9	96	441.9	225.2	56	495.4	252.4
17	282.5	143.9	77	335.9	171.2	37	389.4	198.4	97	442.8	225.6	57	496.3	252.9
18	283.3	144.4	78	336.8	171.6	38	390.3	198.9	98	443.7	226.1	58	497.2	253.3
19	284.2	144.8	79	337.7	172.1	39	391.2	199.3	99	444.6	226.5	59	498.1	253.8
20	285.1	145.3	80	338.6	172.5	40	392.0	199.8	500	445.5	227.0	60	499.0	254.2
321	286.0	145.7	381	339.5	173.0	441	392.9	200.2	501	446.4	227.5	561	499.8	254.7
22	286.9	146.2	82	340.4	173.4	42	393.8	200.7	02	447.3	227.9	62	500.7	255.1
23	287.8	146.6	83	341.3	173.9	43	394.7	201.1	03	448.2	228.4	63	501.6	255.6
24	288.7	147.1	84	342.1	174.3	44	395.6	201.6	04	449.0	228.8	64	502.5	256.0
25	289.6	147.6	85	343.0	174.8	45	396.5	202.0	05	449.9	229.3	65	503.4	256.5
26	290.5	148.0	86	343.9	175.2	46	397.4	202.5	06	450.8	229.8	66	504.3	257.0
27	291.4	148.5	87	344.8	175.7	47	398.3	202.9	07	451.7	230.2	67	505.2	257.4
28	292.3	148.9	88	345.7	176.2	48	399.2	203.4	08	452.6	230.6	68	506.1	257.9
29	293.2	149.4	89	346.6	176.6	49	400.1	203.8	09	453.5	231.0	69	507.0	258.3
30	294.0	149.8	90	347.5	177.1	50	401.0	204.3	10	454.4	231.5	70	507.9	258.8
331	294.9	150.3	391	348.4	177.5	451	401.8	204.7	511	455.3	231.9	571	508.7	259.2
32	295.8	150.7	92	349.3	178.0	52	402.7	205.2	12	456.2	232.4	72	509.6	259.7
33	296.7	151.2	93	350.2	178.4	53	403.6	205.7	13	457.1	232.9	73	510.5	260.1
34	297.6	151.6	94	351.1	178.9	54	404.5	206.1	14	458.0	233.3	74	511.4	260.6
35	298.5	152.1	95	352.0	179.3	55	405.4	206.6	15	458.8	233.8	75	512.3	261.1
36	299.4	152.5	96	352.8	179.8	56	406.3	207.0	16	459.7	234.2	76	513.2	261.5
37	300.3	153.0	97	353.7	180.2	57	407.2	207.5	17	460.6	234.7	77	514.1	262.0
38	301.2	153.5	98	354.6	180.7	58	408.1	207.9	18	461.5	235.2	78	515.0	262.4
39	302.1	153.9	99	355.5	181.2	59	409.0	208.4	19	462.4	235.7	79	515.9	262.9
40	302.9	154.4	400	356.4	181.6	60	409.9	208.8	20	463.3	236.1	80	516.8	263.4
341	303.8	154.8	401	357.3	182.1	461	410.8	209.3	521	464.2	236.6	581	517.7	263.8
42	304.7	155.3	02	358.2	182.5	62	411.6	209.8	22	465.1	237.0	82	518.5	264.3
43	305.6	155.7	03	359.1	183.0	63	412.5	210.2	23	466.0	237.5	83	519.4	264.7
44	306.5	156.2	04	360.0	183.4	64	413.4	210.7	24	466.9	237.9	84	520.3	265.2
45	307.4	156.6	05	360.9	183.9	65	414.3	211.1	25	467.8	238.4	85	521.2	265.6
46	308.3	157.1	06	361.8	184.3	66	415.2	211.6	26	468.7	238.8	86	522.1	266.0
47	309.2	157.5	07	362.6	184.8	67	416.1	212.0	27	469.5	239.3	87	523.0	266.5
48	310.1	158.0	08	363.5	185.2	68	417.0	212.5	28	470.4	239.7	88	523.9	267.0
49	311.0	158.5	09	364.4	185.7	69	417.9	212.9	29	471.3	240.2	89	524.8	267.4
50	311.9	158.9	10	365.3	186.1	70	418.8	213.4	30	472.2	240.6	90	525.7	267.9
351	312.7	159.4	411	366.2	186.6	471	419.7	213.8	531	473.1	241.1	591	526.6	268.3
52	313.6	159.8	12	367.1	187.1	72	420.6	214.3	32	474.0	241.5	92	527.5	268.8
53	314.5	160.3	13	368.0	187.5	73	421.4	214.7	33	474.9	242.0	93	528.4	269.2
54	315.4	160.7	14	368.9	188.0	74	422.3	215.2	34	475.8	242.4	94	529.3	269.7
55	316.3	161.2	15	369.8	188.4	75	423.2	215.7	35	476.7	242.9	95	530.1	270.1
56	317.2	161.6	16	370.7	188.9	76	424.1	216.1	36	477.6	243.4	96	531.0	270.6
57	318.1	162.1	17	371.6	189.3	77	425.0	216.6	37	478.4	243.8	97	531.9	271.1
58	319.0	162.5	18	372.4	189.8	78	425.9	217.0	38	479.3	244.3	98	532.8	271.5
59	319.9	163.0	19	373.3	190.2	79	426.8	217.5	39	480.2	244.7	99	533.7	272.0
60	320.8	163.4	20	374.2	190.7	80	427.7	217.9	40	481.1	245.2	600	534.6	272.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

63° (117°, 243°, 297°).

TABLE 2.

Difference of Latitude and Departure for 28° (152°, 208°, 332°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	0.9	0.5	61	53.9	28.6	121	106.8	56.8	181	159.8	85.0	241	212.8	113.1
2	1.8	0.9	62	54.7	29.1	22	107.7	57.3	82	160.7	85.4	42	213.7	113.6
3	2.6	1.4	63	55.6	29.6	23	108.6	57.7	83	161.6	85.9	43	214.6	114.1
4	3.5	1.9	64	56.5	30.0	24	109.5	58.2	84	162.5	86.4	44	215.4	114.6
5	4.4	2.3	65	57.4	30.5	25	110.4	58.7	85	163.3	86.9	45	216.3	115.0
6	5.3	2.8	66	58.3	31.0	26	111.3	59.2	86	164.2	87.3	46	217.2	115.5
7	6.2	3.3	67	59.2	31.5	27	112.1	59.6	87	165.1	87.8	47	218.1	116.0
8	7.1	3.8	68	60.0	31.9	28	113.0	60.1	88	166.0	88.3	48	219.0	116.4
9	7.9	4.2	69	60.9	32.4	29	113.9	60.6	89	166.9	88.7	49	219.9	116.9
10	8.8	4.7	70	61.8	32.9	30	114.8	61.0	90	167.8	89.2	50	220.7	117.4
11	9.7	5.2	71	62.7	33.3	131	115.7	61.5	191	168.6	89.7	251	221.6	117.8
12	10.6	5.6	72	63.6	33.8	32	116.5	62.0	92	169.5	90.1	52	222.5	118.3
13	11.5	6.1	73	64.5	34.3	33	117.4	62.4	93	170.4	90.6	53	223.4	118.8
14	12.4	6.6	74	65.3	34.7	34	118.3	62.9	94	171.3	91.1	54	224.3	119.2
15	13.2	7.0	75	66.2	35.2	35	119.2	63.4	95	172.2	91.5	55	225.2	119.7
16	14.1	7.5	76	67.1	35.7	36	120.1	63.8	96	173.1	92.0	56	226.0	120.2
17	15.0	8.0	77	68.0	36.1	37	121.0	64.3	97	173.9	92.5	57	226.9	120.7
18	15.9	8.5	78	68.9	36.6	38	121.8	64.8	98	174.8	93.0	58	227.8	121.1
19	16.8	8.9	79	69.8	37.1	39	122.7	65.3	99	175.7	93.4	59	228.7	121.6
20	17.7	9.4	80	70.6	37.6	40	123.6	65.7	200	176.6	93.9	60	229.6	122.1
21	18.5	9.9	81	71.5	38.0	141	124.5	66.2	201	177.5	94.4	261	230.4	122.5
22	19.4	10.3	82	72.4	38.5	42	125.4	66.7	02	178.4	94.8	62	231.3	123.0
23	20.3	10.8	83	73.3	39.0	43	126.3	67.1	03	179.2	95.3	63	232.2	123.5
24	21.2	11.3	84	74.2	39.4	44	127.1	67.6	04	180.1	95.8	64	233.1	123.9
25	22.1	11.7	85	75.1	39.9	45	128.0	68.1	05	181.0	96.2	65	234.0	124.4
26	23.0	12.2	86	75.9	40.4	46	128.9	68.5	06	181.9	96.7	66	234.9	124.9
27	23.8	12.7	87	76.8	40.8	47	129.8	69.0	07	182.8	97.2	67	235.7	125.3
28	24.7	13.1	88	77.7	41.3	48	130.7	69.5	08	183.7	97.7	68	236.6	125.8
29	25.6	13.6	89	78.6	41.8	49	131.6	70.0	09	184.5	98.1	69	237.5	126.3
30	26.5	14.1	90	79.5	42.3	50	132.4	70.4	10	185.4	98.6	70	238.4	126.8
31	27.4	14.6	91	80.3	42.7	151	133.3	70.9	211	186.3	99.1	271	239.3	127.2
32	28.3	15.0	92	81.2	43.2	52	134.2	71.4	12	187.2	99.5	72	240.2	127.7
33	29.1	15.5	93	82.1	43.7	53	135.1	71.8	13	188.1	100.0	73	241.0	128.2
34	30.0	16.0	94	83.0	44.1	54	136.0	72.3	14	189.0	100.5	74	241.9	128.6
35	30.9	16.4	95	83.9	44.6	55	136.9	72.8	15	189.8	100.9	75	242.8	129.1
36	31.8	16.9	96	84.8	45.1	56	137.7	73.2	16	190.7	101.4	76	243.7	129.6
37	32.7	17.4	97	85.6	45.5	57	138.6	73.7	17	191.6	101.9	77	244.6	130.0
38	33.6	17.8	98	86.5	46.0	58	139.5	74.2	18	192.5	102.3	78	245.5	130.5
39	34.4	18.3	99	87.4	46.5	59	140.4	74.6	19	193.4	102.8	79	246.3	131.0
40	35.3	18.8	100	88.3	46.9	60	141.3	75.1	20	194.2	103.3	80	247.2	131.5
41	36.2	19.2	101	89.2	47.4	161	142.2	75.6	221	195.1	103.8	281	248.1	131.9
42	37.1	19.7	02	90.1	47.9	62	143.0	76.1	22	196.0	104.2	82	249.0	132.4
43	38.0	20.2	03	90.9	48.4	63	143.9	76.5	23	196.9	104.7	83	249.9	132.9
44	38.8	20.7	04	91.8	48.8	64	144.8	77.0	24	197.8	105.2	84	250.8	133.3
45	39.7	21.1	05	92.7	49.3	65	145.7	77.5	25	198.7	105.6	85	251.6	133.8
46	40.6	21.6	06	93.6	49.8	66	146.6	77.9	26	199.5	106.1	86	252.5	134.3
47	41.5	22.1	07	94.5	50.2	67	147.5	78.4	27	200.4	106.6	87	253.4	134.7
48	42.4	22.5	08	95.4	50.7	68	148.3	78.9	28	201.3	107.0	88	254.3	135.2
49	43.3	23.0	09	96.2	51.2	69	149.2	79.3	29	202.2	107.5	89	255.2	135.7
50	44.1	23.5	10	97.1	51.6	70	150.1	79.8	30	203.1	108.0	90	256.1	136.1
51	45.0	23.9	111	98.0	52.1	171	151.0	80.3	231	204.0	108.4	291	256.9	136.6
52	45.9	24.4	12	98.9	52.6	72	151.9	80.7	32	204.8	108.9	92	257.8	137.1
53	46.8	24.9	13	99.8	53.1	73	152.7	81.2	33	205.7	109.4	93	258.7	137.6
54	47.7	25.4	14	100.7	53.5	74	153.6	81.7	34	206.6	109.9	94	259.6	138.0
55	48.6	25.8	15	101.5	54.0	75	154.5	82.2	35	207.5	110.3	95	260.5	138.5
56	49.4	26.3	16	102.4	54.5	76	155.4	82.6	36	208.4	110.8	96	261.4	139.0
57	50.3	26.8	17	103.3	54.9	77	156.3	83.1	37	209.3	111.3	97	262.2	139.4
58	51.2	27.2	18	104.2	55.4	78	157.2	83.6	38	210.1	111.7	98	263.1	139.9
59	52.1	27.7	19	105.1	55.9	79	158.0	84.0	39	211.0	112.2	99	264.0	140.4
60	53.0	28.2	20	106.0	56.3	80	158.9	84.5	40	211.9	112.7	300	264.9	140.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

62° (118°, 242°, 298°).

TABLE 2.

Difference of Latitude and Departure for 28° (152°, 208°, 332°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	265.7	141.3	361	318.7	169.5	421	371.7	197.7	481	424.7	225.8	541	477.7	254.0
02	266.6	141.8	62	319.6	170.0	22	372.6	198.1	82	425.6	226.3	42	478.6	254.5
03	267.5	142.3	63	320.5	170.4	23	373.5	198.6	83	426.5	226.8	43	479.4	255.0
04	268.4	142.7	64	321.4	170.9	24	374.3	199.1	84	427.4	227.3	44	480.3	255.5
05	269.3	143.2	65	322.2	171.4	25	375.2	199.5	85	428.3	227.7	45	481.1	255.9
06	270.2	143.7	66	323.1	171.8	26	376.1	200.0	86	429.2	228.2	46	482.0	256.4
07	271.0	144.1	67	324.0	172.3	27	377.0	200.5	87	430.1	228.6	47	482.9	256.9
08	271.9	144.6	68	324.9	172.8	28	377.9	200.9	88	430.9	229.1	48	483.8	257.3
09	272.8	145.1	69	325.8	173.2	29	378.8	201.4	89	431.8	229.6	49	484.7	257.8
10	273.7	145.5	70	326.7	173.7	30	379.6	201.9	90	432.6	230.0	50	485.6	258.2
311	274.6	146.0	371	327.5	174.2	431	380.5	202.3	491	433.5	230.5	551	486.5	258.7
12	275.5	146.5	72	328.4	174.6	32	381.4	202.8	92	434.4	231.0	52	487.4	259.1
13	276.3	146.9	73	329.3	175.1	33	382.3	203.3	93	435.3	231.4	53	488.3	259.6
14	277.2	147.4	74	330.2	175.6	34	383.2	203.8	94	436.2	231.9	54	489.2	260.1
15	278.1	147.9	75	331.1	176.1	35	384.1	204.2	95	437.1	232.4	55	490.1	260.6
16	279.0	148.4	76	332.0	176.5	36	384.9	204.7	96	437.9	232.9	56	490.9	261.0
17	279.9	148.8	77	332.8	177.0	37	385.8	205.2	97	438.8	233.4	57	491.8	261.5
18	280.7	149.3	78	333.7	177.5	38	386.7	205.6	98	439.7	233.8	58	492.7	262.0
19	281.6	149.8	79	334.6	177.9	39	387.6	206.1	99	440.6	234.3	59	493.5	262.5
20	282.5	150.2	80	335.5	178.4	40	388.5	206.6	500	441.5	234.7	60	494.4	262.9
321	283.4	150.7	381	336.4	178.9	441	389.4	207.0	501	442.3	235.2	561	495.3	263.4
22	284.3	151.2	82	337.3	179.3	42	390.2	207.5	02	443.2	235.6	62	496.2	263.8
23	285.2	151.6	83	338.1	179.8	43	391.1	208.0	03	444.1	236.1	63	497.1	264.3
24	286.0	152.1	84	339.0	180.3	44	392.0	208.4	04	445.0	236.6	64	498.0	264.7
25	286.9	152.6	85	339.9	180.8	45	392.9	208.9	05	445.9	237.1	65	498.9	265.2
26	287.8	153.1	86	340.8	181.2	46	393.8	209.4	06	446.8	237.5	66	499.8	265.7
27	288.7	153.5	87	341.7	181.7	47	394.6	209.9	07	447.6	238.0	67	500.7	266.2
28	289.6	154.0	88	342.6	182.2	48	395.5	210.3	08	448.5	238.5	68	501.6	266.6
29	290.5	154.5	89	343.4	182.6	49	396.4	210.8	09	449.4	239.0	69	502.4	267.1
30	291.3	154.9	90	344.3	183.1	50	397.3	211.3	10	450.3	239.4	70	503.3	267.6
331	292.2	155.4	391	345.2	183.6	451	398.2	211.7	511	451.2	239.9	571	504.2	268.0
32	293.1	155.9	92	346.1	184.0	52	399.1	212.2	12	452.1	240.4	72	505.1	268.5
33	294.0	156.3	93	347.0	184.5	53	399.9	212.7	13	452.9	240.8	73	505.9	269.0
34	294.9	156.8	94	347.9	185.0	54	400.8	213.1	14	453.8	241.3	74	506.8	269.4
35	295.8	157.3	95	348.7	185.4	55	401.7	213.6	15	454.7	241.8	75	507.7	269.9
36	296.6	157.7	96	349.6	185.9	56	402.6	214.1	16	455.6	242.2	76	508.6	270.4
37	297.5	158.2	97	350.5	186.4	57	403.5	214.6	17	456.4	242.7	77	509.4	270.9
38	298.4	158.7	98	351.4	186.9	58	404.4	215.0	18	457.3	243.2	78	510.3	271.3
39	299.3	159.2	99	352.3	187.3	59	405.2	215.5	19	458.2	243.7	79	511.2	271.8
40	300.2	159.6	400	353.1	187.8	60	406.1	216.0	20	459.1	244.1	80	512.1	272.3
341	301.0	160.1	401	354.0	188.3	461	407.0	216.4	521	460.0	244.6	581	513.0	272.7
42	301.9	160.6	02	354.9	188.7	62	407.9	216.9	22	460.9	245.0	82	513.9	273.2
43	302.8	161.0	03	355.8	189.2	63	408.8	217.4	23	461.8	245.5	83	514.8	273.7
44	303.7	161.5	04	356.7	189.7	64	409.7	217.8	24	462.7	246.0	84	515.7	274.2
45	304.6	162.0	05	357.6	190.1	65	410.5	218.3	25	463.5	246.5	85	516.5	274.7
46	305.5	162.4	06	358.4	190.6	66	411.4	218.8	26	464.4	246.9	86	517.4	275.1
47	306.4	162.9	07	359.3	191.1	67	412.3	219.2	27	465.3	247.4	87	518.3	275.5
48	307.2	163.4	08	360.2	191.5	68	413.2	219.7	28	466.2	247.9	88	519.2	276.0
49	308.1	163.8	09	361.1	192.0	69	414.1	220.2	29	467.1	248.3	89	520.1	276.5
50	309.0	164.3	10	362.0	192.5	70	415.0	220.7	30	468.0	248.8	90	521.0	277.0
351	309.9	164.8	411	362.9	193.0	471	415.8	221.1	531	468.9	249.3	591	521.8	277.4
52	310.8	165.3	12	363.7	193.4	72	416.7	221.6	32	469.8	249.8	92	522.6	277.9
53	311.7	165.7	13	364.6	193.9	73	417.6	222.1	33	470.7	250.2	93	523.5	278.4
54	312.5	166.2	14	365.5	194.4	74	418.5	222.5	34	471.5	250.7	94	524.4	278.8
55	313.4	166.7	15	366.4	194.8	75	419.4	223.0	35	472.4	251.1	95	525.3	279.3
56	314.3	167.1	16	367.3	195.3	76	420.3	223.5	36	473.3	251.6	96	526.2	279.8
57	315.2	167.6	17	368.2	195.8	77	421.1	223.9	37	474.2	252.1	97	527.1	280.3
58	316.1	168.1	18	369.0	196.2	78	422.0	224.4	38	475.1	252.6	98	528.0	280.8
59	316.9	168.5	19	369.9	196.7	79	422.9	224.9	39	476.0	253.1	99	528.9	281.3
60	317.8	169.0	20	370.8	197.2	80	423.8	225.3	40	476.8	253.6	600	529.8	281.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

62° (118°, 242°, 298°).

TABLE 2.

Difference of Latitude and Departure for 29° (151°, 209°, 331°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	0.9	0.5	61	53.4	29.6	121	105.8	58.7	181	158.3	87.8	241	210.8	116.8
2	1.7	1.0	62	54.2	30.1	22	106.7	59.1	82	159.2	88.2	42	211.7	117.3
3	2.6	1.5	63	55.1	30.5	23	107.6	59.6	83	160.1	88.7	43	212.5	117.8
4	3.5	1.9	64	56.0	31.0	24	108.5	60.1	84	160.9	89.2	44	213.4	118.3
5	4.4	2.4	65	56.9	31.5	25	109.3	60.6	85	161.8	89.7	45	214.3	118.8
6	5.2	2.9	66	57.7	32.0	26	110.2	61.1	86	162.7	90.2	46	215.2	119.3
7	6.1	3.4	67	58.6	32.5	27	111.1	61.6	87	163.6	90.7	47	216.0	119.7
8	7.0	3.9	68	59.5	33.0	28	112.0	62.1	88	164.4	91.1	48	216.9	120.2
9	7.9	4.4	69	60.3	33.5	29	112.8	62.5	89	165.3	91.6	49	217.8	120.7
10	8.7	4.8	70	61.2	33.9	30	113.7	63.0	90	166.2	92.1	50	218.7	121.2
11	9.6	5.3	71	62.1	34.4	131	114.6	63.5	191	167.1	92.6	251	219.5	121.7
12	10.5	5.8	72	63.0	34.9	32	115.4	64.0	92	167.9	93.1	52	220.4	122.2
13	11.4	6.3	73	63.8	35.4	33	116.3	64.5	93	168.8	93.6	53	221.3	122.7
14	12.2	6.8	74	64.7	35.9	34	117.2	65.0	94	169.7	94.1	54	222.2	123.1
15	13.1	7.3	75	65.6	36.4	35	118.1	65.4	95	170.6	94.5	55	223.0	123.6
16	14.0	7.8	76	66.5	36.8	36	118.9	65.9	96	171.4	95.0	56	223.9	124.1
17	14.9	8.2	77	67.3	37.3	37	119.8	66.4	97	172.3	95.5	57	224.8	124.6
18	15.7	8.7	78	68.2	37.8	38	120.7	66.9	98	173.2	96.0	58	225.7	125.1
19	16.6	9.2	79	69.1	38.3	39	121.6	67.4	99	174.0	96.5	59	226.5	125.6
20	17.5	9.7	80	70.0	38.8	40	122.4	67.9	200	174.9	97.0	60	227.4	126.1
21	18.4	10.2	81	70.8	39.3	141	123.3	68.4	201	175.8	97.4	261	228.3	126.5
22	19.2	10.7	82	71.7	39.8	42	124.2	68.8	02	176.7	97.9	62	229.2	127.0
23	20.1	11.2	83	72.6	40.2	43	125.1	69.3	03	177.5	98.4	63	230.0	127.5
24	21.0	11.6	84	73.5	40.7	44	125.9	69.8	04	178.4	98.9	64	230.9	128.0
25	21.9	12.1	85	74.3	41.2	45	126.8	70.3	05	179.3	99.4	65	231.8	128.5
26	22.7	12.6	86	75.2	41.7	46	127.7	70.8	06	180.2	99.9	66	232.6	129.0
27	23.6	13.1	87	76.1	42.2	47	128.6	71.3	07	181.0	100.4	67	233.5	129.4
28	24.5	13.6	88	77.0	42.7	48	129.4	71.8	08	181.9	100.8	68	234.4	129.9
29	25.4	14.1	89	77.8	43.1	49	130.3	72.2	09	182.8	101.3	69	235.3	130.4
30	26.2	14.5	90	78.7	43.6	50	131.2	72.7	10	183.7	101.8	70	236.1	130.9
31	27.1	15.0	91	79.6	44.1	151	132.1	73.2	211	184.5	102.3	271	237.0	131.4
32	28.0	15.5	92	80.5	44.6	52	132.9	73.7	12	185.4	102.8	72	237.9	131.9
33	28.9	16.0	93	81.3	45.1	53	133.8	74.2	13	186.3	103.3	73	238.8	132.4
34	29.7	16.5	94	82.2	45.6	54	134.7	74.7	14	187.2	103.7	74	239.6	132.8
35	30.6	17.0	95	83.1	46.1	55	135.6	75.1	15	188.0	104.2	75	240.5	133.3
36	31.5	17.5	96	84.0	46.5	56	136.4	75.6	16	188.9	104.7	76	241.4	133.8
37	32.4	17.9	97	84.8	47.0	57	137.3	76.1	17	189.8	105.2	77	242.3	134.3
38	33.2	18.4	98	85.7	47.5	58	138.2	76.6	18	190.7	105.7	78	243.1	134.8
39	34.1	18.9	99	86.6	48.0	59	139.1	77.1	19	191.5	106.2	79	244.0	135.3
40	35.0	19.4	100	87.5	48.5	60	139.9	77.6	20	192.4	106.7	80	244.9	135.7
41	35.9	19.9	101	88.3	49.0	161	140.8	78.1	221	193.3	107.1	281	245.8	136.2
42	36.7	20.4	02	89.2	49.5	62	141.7	78.5	22	194.2	107.6	82	246.6	136.7
43	37.6	20.8	03	90.1	49.9	63	142.6	79.0	23	195.0	108.1	83	247.5	137.2
44	38.5	21.3	04	91.0	50.4	64	143.4	79.5	24	195.9	108.6	84	248.4	137.7
45	39.4	21.8	05	91.8	50.9	65	144.3	80.0	25	196.8	109.1	85	249.3	138.2
46	40.2	22.3	06	92.7	51.4	66	145.2	80.5	26	197.7	109.6	86	250.1	138.7
47	41.1	22.8	07	93.6	51.9	67	146.1	81.0	27	198.5	110.1	87	251.0	139.1
48	42.0	23.3	08	94.5	52.4	68	146.9	81.4	28	199.4	110.5	88	251.9	139.6
49	42.9	23.8	09	95.3	52.8	69	147.8	81.9	29	200.3	111.0	89	252.8	140.1
50	43.7	24.2	10	96.2	53.3	70	148.7	82.4	30	201.2	111.5	90	253.6	140.6
51	44.6	24.7	111	97.1	53.8	171	149.6	82.9	231	202.0	112.0	291	254.5	141.1
52	45.5	25.2	12	98.0	54.3	72	150.4	83.4	32	202.9	112.5	92	255.4	141.6
53	46.4	25.7	13	98.8	54.8	73	151.3	83.9	33	203.8	113.0	93	256.3	142.0
54	47.2	26.2	14	99.7	55.3	74	152.2	84.4	34	204.7	113.4	94	257.1	142.5
55	48.1	26.7	15	100.6	55.8	75	153.1	84.8	35	205.5	113.9	95	258.0	143.0
56	49.0	27.1	16	101.5	56.2	76	153.9	85.3	36	206.4	114.4	96	258.9	143.5
57	49.9	27.6	17	102.3	56.7	77	154.8	85.8	37	207.3	114.9	97	259.8	144.0
58	50.7	28.1	18	103.2	57.2	78	155.7	86.3	38	208.2	115.4	98	260.6	144.5
59	51.6	28.6	19	104.1	57.7	79	156.6	86.8	39	209.0	115.9	99	261.5	145.0
60	52.5	29.1	20	105.0	58.2	80	157.4	87.3	40	209.9	116.4	300	262.4	145.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

61° (119°, 241°, 299°).

TABLE 2.

Difference of Latitude and Departure for 29° (151°, 209°, 331°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	263.2	145.9	361	315.7	175.0	421	368.2	204.1	481	420.7	233.2	541	473.2	262.3
02	264.1	146.4	62	316.6	175.5	22	369.1	204.6	82	421.5	233.7	42	474.0	262.8
03	265.0	146.9	63	317.5	176.0	23	369.9	205.1	83	422.4	234.2	43	474.9	263.2
04	265.9	147.4	64	318.3	176.5	24	370.8	205.6	84	423.3	234.6	44	475.8	263.7
05	266.7	147.9	65	319.2	177.0	25	371.7	206.0	85	424.2	235.1	45	476.6	264.2
06	267.6	148.4	66	320.1	177.4	26	372.6	206.5	86	425.0	235.6	46	477.5	264.7
07	268.5	148.8	67	321.0	177.9	27	373.4	207.0	87	425.9	236.1	47	478.4	265.2
08	269.4	149.3	68	321.8	178.4	28	374.3	207.5	88	426.8	236.6	48	479.3	265.7
09	270.2	149.8	69	322.7	178.9	29	375.2	208.0	89	427.7	237.1	49	480.1	266.2
10	271.1	150.3	70	323.6	179.4	30	376.1	208.5	90	428.5	237.6	50	481.0	266.6
311	272.0	150.8	371	324.5	179.9	431	376.9	209.0	491	429.4	238.0	551	481.9	267.1
12	272.9	151.3	72	325.3	180.4	32	377.8	209.4	92	430.3	238.5	52	482.8	267.6
13	273.7	151.7	73	326.2	180.8	33	378.7	209.9	93	431.2	239.0	53	483.6	268.1
14	274.6	152.2	74	327.1	181.3	34	379.6	210.4	94	432.0	239.5	54	484.5	268.6
15	275.5	152.7	75	328.0	181.8	35	380.4	210.9	95	432.9	240.0	55	485.4	269.1
16	276.3	153.2	76	328.8	182.3	36	381.3	211.4	96	433.8	240.5	56	486.3	269.5
17	277.2	153.7	77	329.7	182.8	37	382.2	211.9	97	434.7	240.9	57	437.1	270.0
18	278.1	154.2	78	330.6	183.3	38	383.1	212.3	98	435.5	241.4	58	488.0	270.5
19	279.0	154.7	79	331.4	183.7	39	383.9	212.8	99	436.4	241.9	59	488.9	271.0
20	279.8	155.1	80	332.3	184.2	40	384.8	213.3	500	437.3	242.4	60	489.8	271.5
321	280.7	155.6	381	333.2	184.7	441	385.7	213.8	501	438.2	242.9	561	490.6	272.0
22	281.6	156.1	82	334.1	185.2	42	386.6	214.3	02	439.0	243.4	62	491.5	272.5
23	282.5	156.6	83	334.9	185.7	43	387.4	214.8	03	439.9	243.9	63	492.4	272.9
24	283.3	157.1	84	335.8	186.2	44	388.3	215.3	04	440.8	244.3	64	493.2	273.4
25	284.2	157.6	85	336.7	186.7	45	389.2	215.7	05	441.6	244.8	65	494.1	273.9
26	285.1	158.1	86	337.6	187.1	46	390.0	216.2	06	442.5	245.3	66	495.0	274.4
27	286.0	158.5	87	338.4	187.6	47	390.9	216.7	07	443.4	245.8	67	495.9	274.9
28	286.8	159.0	88	339.3	188.1	48	391.8	217.2	08	444.3	246.3	68	496.8	275.4
29	287.7	159.5	89	340.2	188.6	49	392.7	217.7	09	445.2	246.8	69	497.7	275.9
30	288.6	160.0	90	341.1	189.1	50	393.5	218.2	10	446.1	247.3	70	498.5	276.3
331	289.5	160.5	391	341.9	189.6	451	394.4	218.7	511	447.0	247.8	571	499.4	276.8
32	290.3	161.0	92	342.8	190.0	52	395.3	219.1	12	447.8	248.2	72	500.3	277.3
33	291.2	161.4	93	343.7	190.5	53	396.2	219.6	13	448.6	248.7	73	501.1	277.8
34	292.1	161.9	94	344.6	191.0	54	397.0	220.1	14	449.5	249.2	74	502.0	278.3
35	293.0	162.4	95	345.4	191.5	55	397.9	220.6	15	450.4	249.7	75	502.9	278.8
36	293.8	162.9	96	346.3	192.0	56	398.8	221.1	16	451.3	250.2	76	503.7	279.2
37	294.7	163.4	97	347.2	192.5	57	399.7	221.6	17	452.2	250.6	77	504.6	279.7
38	295.6	163.9	98	348.1	193.0	58	400.5	222.0	18	453.1	251.1	78	505.5	280.2
39	296.5	164.4	99	348.9	193.4	59	401.4	222.5	19	453.9	251.6	79	506.4	280.7
40	297.3	164.8	400	349.8	193.9	60	402.3	223.0	20	454.8	252.1	80	507.2	281.2
341	298.2	165.3	401	350.7	194.4	461	403.2	223.5	521	455.6	252.6	581	508.1	281.7
42	299.1	165.8	02	351.6	194.9	62	404.0	224.0	22	456.5	253.1	82	509.0	282.2
43	300.0	166.3	03	352.4	195.4	63	404.9	224.5	23	457.4	253.6	83	509.9	282.7
44	300.8	166.8	04	353.3	195.9	64	405.8	225.0	24	458.3	254.0	84	510.7	283.2
45	301.7	167.3	05	354.2	196.3	65	406.7	225.4	25	459.1	254.5	85	511.6	283.6
46	302.6	167.7	06	355.1	196.8	66	407.5	225.9	26	460.0	255.0	86	512.5	284.1
47	303.5	168.2	07	355.9	197.3	67	408.4	226.4	27	460.9	255.5	87	513.4	284.6
48	304.3	168.7	08	356.8	197.8	68	409.3	226.9	28	461.8	256.0	88	514.3	285.0
49	305.2	169.2	09	357.7	198.3	69	410.2	227.4	29	462.6	256.5	89	515.1	285.5
50	306.1	169.7	10	358.6	198.8	70	411.0	227.9	30	463.5	256.9	90	516.0	286.0
351	307.0	170.2	411	359.4	199.3	471	411.9	228.3	531	464.4	257.4	591	516.9	286.5
52	307.8	170.7	12	360.3	199.7	72	412.8	228.8	32	465.3	257.9	92	517.7	287.0
53	308.7	171.1	13	361.2	200.2	73	413.7	229.3	33	466.1	258.4	93	518.6	287.5
54	309.6	171.6	14	362.1	200.7	74	414.5	229.8	34	467.0	258.9	94	519.5	288.0
55	310.5	172.1	15	362.9	201.2	75	415.4	230.3	35	467.9	259.4	95	520.4	288.5
56	311.3	172.6	16	363.8	201.7	76	416.3	230.8	36	468.8	259.9	96	521.2	288.9
57	312.2	173.1	17	364.7	202.2	77	417.2	231.3	37	469.6	260.3	97	522.1	289.4
58	313.1	173.6	18	365.6	202.7	78	418.0	231.7	38	470.5	260.8	98	523.0	289.9
59	314.0	174.0	19	366.4	203.1	79	418.9	232.2	39	471.4	261.3	99	523.9	290.4
60	314.8	174.5	20	367.3	203.6	80	419.8	232.7	40	472.3	261.8	600	524.8	290.9
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

61° (119°, 241°, 299°).

TABLE 2.

Difference of Latitude and Departure for 30° (150°, 210°, 330°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	0.9	0.5	61	52.8	30.5	121	104.8	60.5	181	156.8	90.5	241	208.7	120.5
2	1.7	1.0	62	53.7	31.0	22	105.7	61.0	82	157.6	91.0	42	209.6	121.0
3	2.6	1.5	63	54.6	31.5	23	106.5	61.5	83	158.5	91.5	43	210.4	121.5
4	3.5	2.0	64	55.4	32.0	24	107.4	62.0	84	159.3	92.0	44	211.3	122.0
5	4.3	2.5	65	56.3	32.5	25	108.3	62.5	85	160.2	92.5	45	212.2	122.5
6	5.2	3.0	66	57.2	33.0	26	109.1	63.0	86	161.1	93.0	46	213.0	123.0
7	6.1	3.5	67	58.0	33.5	27	110.0	63.5	87	161.9	93.5	47	213.9	123.5
8	6.9	4.0	68	58.9	34.0	28	110.9	64.0	88	162.8	94.0	48	214.8	124.0
9	7.8	4.5	69	59.8	34.5	29	111.7	64.5	89	163.7	94.5	49	215.6	124.5
10	8.7	5.0	70	60.6	35.0	30	112.6	65.0	90	164.5	95.0	50	216.5	125.0
11	9.5	5.5	71	61.5	35.5	131	113.4	65.5	191	165.4	95.5	251	217.4	125.5
12	10.4	6.0	72	62.4	36.0	32	114.3	66.0	92	166.3	96.0	52	218.2	126.0
13	11.3	6.5	73	63.2	36.5	33	115.2	66.5	93	167.1	96.5	53	219.1	126.5
14	12.1	7.0	74	64.1	37.0	34	116.0	67.0	94	168.0	97.0	54	220.0	127.0
15	13.0	7.5	75	65.0	37.5	35	116.9	67.5	95	168.9	97.5	55	220.8	127.5
16	13.9	8.0	76	65.8	38.0	36	117.8	68.0	96	169.7	98.0	56	221.7	128.0
17	14.7	8.5	77	66.7	38.5	37	118.6	68.5	97	170.6	98.5	57	222.6	128.5
18	15.6	9.0	78	67.5	39.0	38	119.5	69.0	98	171.5	99.0	58	223.4	129.0
19	16.5	9.5	79	68.4	39.5	39	120.4	69.5	99	172.3	99.5	59	224.3	129.5
20	17.3	10.0	80	69.3	40.0	40	121.2	70.0	200	173.2	100.0	60	225.2	130.0
21	18.2	10.5	81	70.1	40.5	141	122.1	70.5	201	174.1	100.5	261	226.0	130.5
22	19.1	11.0	82	71.0	41.0	42	123.0	71.0	02	174.9	101.0	62	226.9	131.0
23	19.9	11.5	83	71.9	41.5	43	123.8	71.5	03	175.8	101.5	63	227.8	131.5
24	20.8	12.0	84	72.7	42.0	44	124.7	72.0	04	176.7	102.0	64	228.6	132.0
25	21.7	12.5	85	73.6	42.5	45	125.6	72.5	05	177.5	102.5	65	229.5	132.5
26	22.5	13.0	86	74.5	43.0	46	126.4	73.0	06	178.4	103.0	66	230.4	133.0
27	23.4	13.5	87	75.3	43.5	47	127.3	73.5	07	179.3	103.5	67	231.2	133.5
28	24.2	14.0	88	76.2	44.0	48	128.2	74.0	08	180.1	104.0	68	232.1	134.0
29	25.1	14.5	89	77.1	44.5	49	129.0	74.5	09	181.0	104.5	69	233.0	134.5
30	26.0	15.0	90	77.9	45.0	50	129.9	75.0	10	181.9	105.0	70	233.8	135.0
31	26.8	15.5	91	78.8	45.5	151	130.8	75.5	211	182.7	105.5	271	234.7	135.5
32	27.7	16.0	92	79.7	46.0	52	131.6	76.0	12	183.6	106.0	72	235.6	136.0
33	28.6	16.5	93	80.5	46.5	53	132.5	76.5	13	184.5	106.5	73	236.4	136.5
34	29.4	17.0	94	81.4	47.0	54	133.4	77.0	14	185.3	107.0	74	237.3	137.0
35	30.3	17.5	95	82.3	47.5	55	134.2	77.5	15	186.2	107.5	75	238.2	137.5
36	31.2	18.0	96	83.1	48.0	56	135.1	78.0	16	187.1	108.0	76	239.0	138.0
37	32.0	18.5	97	84.0	48.5	57	136.0	78.5	17	187.9	108.5	77	239.9	138.5
38	32.9	19.0	98	84.9	49.0	58	136.8	79.0	18	188.8	109.0	78	240.8	139.0
39	33.8	19.5	99	85.7	49.5	59	137.7	79.5	19	189.7	109.5	79	241.6	139.5
40	34.6	20.0	100	86.6	50.0	60	138.6	80.0	20	190.5	110.0	80	242.5	140.0
41	35.5	20.5	101	87.5	50.5	161	139.4	80.5	221	191.4	110.5	281	243.4	140.5
42	36.4	21.0	02	88.3	51.0	62	140.3	81.0	22	192.3	111.0	82	244.2	141.0
43	37.2	21.5	03	89.2	51.5	63	141.2	81.5	23	193.1	111.5	83	245.1	141.5
44	38.1	22.0	04	90.1	52.0	64	142.0	82.0	24	194.0	112.0	84	246.0	142.0
45	39.0	22.5	05	90.9	52.5	65	142.9	82.5	25	194.9	112.5	85	246.8	142.5
46	39.8	23.0	06	91.8	53.0	66	143.8	83.0	26	195.7	113.0	86	247.7	143.0
47	40.7	23.5	07	92.7	53.5	67	144.6	83.5	27	196.6	113.5	87	248.5	143.5
48	41.6	24.0	08	93.5	54.0	68	145.5	84.0	28	197.5	114.0	88	249.4	144.0
49	42.4	24.5	09	94.4	54.5	69	146.4	84.5	29	198.3	114.5	89	250.3	144.5
50	43.3	25.0	10	95.3	55.0	70	147.2	85.0	30	199.2	115.0	90	251.1	145.0
51	44.2	25.5	111	96.1	55.5	171	148.1	85.5	231	200.1	115.5	291	252.0	145.5
52	45.0	26.0	12	97.0	56.0	72	149.0	86.0	32	200.9	116.0	92	252.9	146.0
53	45.9	26.5	13	97.9	56.5	73	149.8	86.5	33	201.8	116.5	93	253.7	146.5
54	46.8	27.0	14	98.7	57.0	74	150.7	87.0	34	202.6	117.0	94	254.6	147.0
55	47.6	27.5	15	99.6	57.5	75	151.6	87.5	35	203.5	117.5	95	255.5	147.5
56	48.5	28.0	16	100.5	58.0	76	152.4	88.0	36	204.4	118.0	96	256.3	148.0
57	49.4	28.5	17	101.3	58.5	77	153.3	88.5	37	205.2	118.5	97	257.2	148.5
58	50.2	29.0	18	102.2	59.0	78	154.2	89.0	38	206.1	119.0	98	258.1	149.0
59	51.1	29.5	19	103.1	59.5	79	155.0	89.5	39	207.0	119.5	99	258.9	149.5
60	52.0	30.0	20	103.9	60.0	80	155.9	90.0	40	207.8	120.0	300	259.8	150.0
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

60° (120°, 240°, 300°).

TABLE 2.

Difference of Latitude and Departure for 30° (150°, 210°, 330°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	260.7	150.5	361	312.6	180.5	421	364.6	210.5	481	416.6	240.5	541	468.5	270.5
02	261.5	151.0	62	313.5	181.0	22	365.5	211.0	82	417.4	241.0	42	469.4	271.0
03	262.4	151.5	63	314.4	181.5	23	366.3	211.5	83	418.3	241.5	43	470.3	271.5
04	263.3	152.0	64	315.2	182.0	24	367.2	212.0	84	419.2	242.0	44	471.1	272.0
05	264.1	152.5	65	316.1	182.5	25	368.1	212.5	85	420.0	242.5	45	472.0	272.5
06	265.0	153.0	66	317.0	183.0	26	368.9	213.0	86	420.9	243.0	46	472.9	273.0
07	265.9	153.5	67	317.8	183.5	27	369.8	213.5	87	421.8	243.5	47	473.7	273.5
08	266.7	154.0	68	318.7	184.0	28	370.7	214.0	88	422.6	244.0	48	474.6	274.0
09	267.6	154.5	69	319.6	184.5	29	371.5	214.5	89	423.5	244.5	49	475.5	274.5
10	268.5	155.0	70	320.4	185.0	30	372.4	215.0	90	424.4	245.0	50	476.3	275.0
311	269.3	155.5	371	321.3	185.5	431	373.3	215.5	491	425.2	245.5	551	477.2	275.5
12	270.2	156.0	72	322.2	186.0	32	374.1	216.0	92	426.1	246.0	52	478.1	276.0
13	271.1	156.5	73	323.0	186.5	33	375.0	216.5	93	426.9	246.5	53	478.9	276.5
14	271.9	157.0	74	323.9	187.0	34	375.9	217.0	94	427.8	247.0	54	479.8	277.0
15	272.8	157.5	75	324.8	187.5	35	376.7	217.5	95	428.7	247.5	55	480.7	277.5
16	273.7	158.0	76	325.6	188.0	36	377.6	218.0	96	429.6	248.0	56	481.5	278.0
17	274.5	158.5	77	326.5	188.5	37	378.5	218.5	97	430.4	248.5	57	482.4	278.5
18	275.4	159.0	78	327.4	189.0	38	379.3	219.0	98	431.3	249.0	58	483.3	279.0
19	276.3	159.5	79	328.2	189.5	39	380.2	219.5	99	432.2	249.5	59	484.1	279.5
20	277.1	160.0	80	329.1	190.0	40	381.1	220.0	500	433.0	250.0	60	485.0	280.0
321	278.0	160.5	381	330.0	190.5	441	381.9	220.5	501	433.9	250.5	561	485.9	280.5
22	278.9	161.0	82	330.8	191.0	42	382.8	221.0	02	434.8	251.0	62	486.7	281.0
23	279.7	161.5	83	331.7	191.5	43	383.7	221.5	03	435.6	251.5	63	487.6	281.5
24	280.6	162.0	84	332.6	192.0	44	384.5	222.0	04	436.5	252.0	64	488.5	282.0
25	281.5	162.5	85	333.4	192.5	45	385.4	222.5	05	437.4	252.5	65	489.3	282.5
26	282.3	163.0	86	334.3	193.0	46	386.3	223.0	06	438.2	253.0	66	490.2	283.0
27	283.2	163.5	87	335.2	193.5	47	387.1	223.5	07	439.1	253.5	67	491.1	283.5
28	284.1	164.0	88	336.0	194.0	48	388.0	224.0	08	440.0	254.0	68	491.9	284.0
29	284.9	164.5	89	336.9	194.5	49	388.9	224.5	09	440.8	254.5	69	492.8	284.5
30	285.8	165.0	90	337.8	195.0	50	389.7	225.0	10	441.7	255.0	70	493.6	285.0
331	286.7	165.5	391	338.6	195.5	451	390.6	225.5	511	442.6	255.5	571	494.5	285.5
32	287.5	166.0	92	339.5	196.0	52	391.5	226.0	12	443.4	256.0	72	495.4	286.0
33	288.4	166.5	93	340.4	196.5	53	392.3	226.5	13	444.3	256.5	73	496.3	286.5
34	289.3	167.0	94	341.2	197.0	54	393.2	227.0	14	445.2	257.0	74	497.1	287.0
35	290.1	167.5	95	342.1	197.5	55	394.0	227.5	15	446.0	257.5	75	497.9	287.5
36	291.0	168.0	96	343.0	198.0	56	394.9	228.0	16	446.9	258.0	76	498.8	288.0
37	291.9	168.5	97	343.8	198.5	57	395.8	228.5	17	447.8	258.5	77	499.7	288.5
38	292.7	169.0	98	344.7	199.0	58	396.6	229.0	18	448.6	259.0	78	500.5	289.0
39	293.6	169.5	99	345.6	199.5	59	397.5	229.5	19	449.4	259.5	79	501.3	289.5
40	294.5	170.0	400	346.4	200.0	60	398.4	230.0	20	450.3	260.0	80	502.2	290.0
341	295.3	170.5	401	347.3	200.5	461	399.2	230.5	521	451.2	260.5	581	503.1	290.5
42	296.2	171.0	02	348.1	201.0	62	400.1	231.0	22	452.1	261.0	82	504.0	291.0
43	297.1	171.5	03	349.0	201.5	63	401.0	231.5	23	452.9	261.5	83	504.9	291.5
44	297.9	172.0	04	349.9	202.0	64	401.8	232.0	24	453.8	262.0	84	505.8	292.0
45	298.8	172.5	05	350.7	202.5	65	402.7	232.5	25	454.7	262.5	85	506.6	292.5
46	299.7	173.0	06	351.6	203.0	66	403.6	233.0	26	455.5	263.0	86	507.5	293.0
47	300.5	173.5	07	352.5	203.5	67	404.4	233.5	27	456.4	263.5	87	508.4	293.5
48	301.4	174.0	08	353.3	204.0	68	405.3	234.0	28	457.3	264.0	88	509.2	294.0
49	302.3	174.5	09	354.2	204.5	69	406.2	234.5	29	458.1	264.5	89	510.1	294.5
50	303.1	175.0	10	355.1	205.0	70	407.0	235.0	30	459.0	265.0	90	511.0	295.0
351	304.0	175.5	411	355.9	205.5	471	407.9	235.5	531	459.9	265.5	591	511.8	295.5
52	304.8	176.0	12	356.8	206.0	72	408.8	236.0	32	460.7	266.0	92	512.7	296.0
53	305.7	176.5	13	357.7	206.5	73	409.6	236.5	33	461.6	266.5	93	513.6	296.5
54	306.6	177.0	14	358.5	207.0	74	410.5	237.0	34	462.5	267.0	94	514.4	297.0
55	307.4	177.5	15	359.4	207.5	75	411.4	237.5	35	463.3	267.5	95	515.3	297.5
56	308.3	178.0	16	360.3	208.0	76	412.2	238.0	36	464.2	268.0	96	516.2	298.0
57	309.2	178.5	17	361.1	208.5	77	413.1	238.5	37	465.1	268.5	97	517.0	298.5
58	310.0	179.0	18	362.0	209.0	78	414.0	239.0	38	465.9	269.0	98	517.9	299.0
59	310.9	179.5	19	362.9	209.5	79	414.8	239.5	39	466.8	269.5	99	518.8	299.5
60	311.8	180.0	20	363.7	210.0	80	415.7	240.0	40	467.7	270.0	600	519.6	300.0
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

60° (120°, 240°, 300°).

TABLE 2.

Difference of Latitude and Departure for 31° (149°, 211°, 329°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	0.9	0.5	61	52.3	31.4	121	103.7	62.3	181	155.1	93.2	241	206.6	124.1
2	1.7	1.0	62	53.1	31.9	22	104.6	62.8	82	156.0	93.7	42	207.4	124.6
3	2.6	1.5	63	54 0	32.4	23	105.4	63.3	83	156.9	94.3	43	208.3	125.2
4	3.4	2.1	64	54.9	33.0	24	106.3	63.9	84	157.7	94.8	44	209.1	125.7
5	4.3	2.6	65	55.7	33.5	25	107.1	64.4	85	158.6	95.3	45	210.0	126.2
6	5.1	3.1	66	56.6	34.0	26	108.0	64.9	86	159.4	95.8	46	210.9	126.7
7	6.0	3.6	67	57.4	34.5	27	108.9	65.4	87	160.3	96.3	47	211.7	127.2
8	6.9	4.1	68	58.3	35.0	28	109.7	65.9	88	161.1	96.8	48	212.6	127.7
9	7.7	4.6	69	59.1	35.5	29	110.6	66.4	89	162.0	97.3	49	213.4	128.2
10	8.6	5.2	70	60.0	36.1	30	111.4	67.0	90	162.9	97.9	50	214.3	128.8
11	9.4	5.7	71	60.9	36.6	131	112.3	67.5	191	163.7	98.4	251	215.1	129.3
12	10.3	6.2	72	61.7	37.1	32	113.1	68.0	92	164.6	98.9	52	216.0	129.8
13	11.1	6.7	73	62.6	37.6	33	114.0	68.5	93	165.4	99.4	53	216.9	130.3
14	12.0	7.2	74	63.4	38.1	34	114.9	69.0	94	166.3	99.9	54	217.7	130.8
15	12.9	7.7	75	64.3	38.6	35	115.7	69.5	95	167.1	100.4	55	218.6	131.3
16	13.7	8.2	76	65.1	39.1	36	116.6	70.0	96	168.0	100.9	56	219.4	131.8
17	14.6	8.8	77	66.0	39.7	37	117.4	70.6	97	168.9	101.5	57	220.3	132.4
18	15.4	9.3	78	66.9	40.2	38	118.3	71.1	98	169.7	102.0	58	221.1	132.9
19	16.3	9.8	79	67.7	40.7	39	119.1	71.6	99	170.6	102.5	59	222.0	133.4
20	17.1	10.3	80	68.6	41.2	40	120.0	72.1	200	171.4	103.0	60	222.9	133.9
21	18.0	10.8	81	69.4	41.7	141	120.9	72.6	201	172.3	103.5	261	223.7	134.4
22	18.9	11.3	82	70.3	42.2	42	121.7	73.1	02	173.1	104.0	62	224.6	134.9
23	19.7	11.8	83	71.1	42.7	43	122.6	73.7	03	174.0	104.6	63	225.4	135.5
24	20.6	12.4	84	72.0	43.3	44	123.4	74.2	04	174.9	105.1	64	226.3	136.0
25	21.4	12.9	85	72.9	43.8	45	124.3	74.7	05	175.7	105.6	65	227.1	136.5
26	22.3	13.4	86	73.7	44.3	46	125.1	75.2	06	176.6	106.1	66	228.0	137.0
27	23.1	13.9	87	74.6	44.8	47	126.0	75.7	07	177.4	106.6	67	228.9	137.5
28	24.0	14.4	88	75.4	45.3	48	126.9	76.2	08	178.3	107.1	68	229.7	138.0
29	24.9	14.9	89	76.3	45.8	49	127.7	76.7	09	179.1	107.6	69	230.6	138.5
30	25.7	15.5	90	77.1	46.4	50	128.6	77.3	10	180.0	108.2	70	231.4	139.1
31	26.6	16.0	91	78.0	46.9	151	129.4	77.8	211	180.9	108.7	271	232.3	139.6
32	27.4	16.5	92	78.9	47.4	52	130.3	78.3	12	181.7	109.2	72	233.1	140.1
33	28.3	17.0	93	79.7	47.9	53	131.1	78.8	13	182.6	109.7	73	234.0	140.6
34	29.1	17.5	94	80.6	48.4	54	132.0	79.3	14	183.4	110.2	74	234.9	141.1
35	30.0	18.0	95	81.4	48.9	55	132.9	79.8	15	184.3	110.7	75	235.7	141.6
36	30.9	18.5	96	82.3	49.4	56	133.7	80.3	16	185.1	111.2	76	236.6	142.2
37	31.7	19.1	97	83.1	50.0	57	134.6	80.9	17	186.0	111.8	77	237.4	142.7
38	32.6	19.6	98	84.0	50.5	58	135.4	81.4	18	186.9	112.3	78	238.3	143.2
39	33.4	20.1	99	84.9	51.0	59	136.3	81.9	19	187.7	112.8	79	239.1	143.7
40	34.3	20.6	100	85.7	51.5	60	137.1	82.4	20	188.6	113.3	80	240.0	144.2
41	35.1	21.1	101	86.6	52.0	161	138.0	82.9	221	189.4	113.8	281	240.9	144.7
42	36.0	21.6	02	87.4	52.5	62	138.9	83.4	22	190.3	114.3	82	241.7	145.2
43	36.9	22.1	03	88.3	53.0	63	139.7	84.0	23	191.1	114.9	83	242.6	145.8
44	37.7	22.7	04	89.1	53.6	64	140.6	84.5	24	192.0	115.4	84	243.4	146.3
45	38.6	23.2	05	90.0	54.1	65	141.4	85.0	25	192.9	115.9	85	244.3	146.8
46	39.4	23.7	06	90.9	54.6	66	142.3	85.5	26	193.7	116.4	86	245.1	147.3
47	40.3	24.2	07	91.7	55.1	67	143.1	86.0	27	194.6	116.9	87	246.0	147.8
48	41.1	24.7	08	92.6	55.6	68	144.0	86.5	28	195.4	117.4	88	246.9	148.3
49	42.0	25.2	09	93.4	56.1	69	144.9	87.0	29	196.3	117.9	89	247.7	148.8
50	42.9	25.8	10	94.3	56.7	70	145.7	87.6	30	197.1	118.5	90	248.6	149.4
51	43.7	26.3	111	95.1	57.2	171	146.6	88.1	231	198.0	119.0	291	249.4	149.9
52	44.6	26.8	12	96.0	57.7	72	147.4	88.6	32	198.9	119.5	92	250.3	150.4
53	45.4	27.3	13	96.9	58.2	73	148.3	89.1	33	199.7	120.0	93	251.2	150.9
54	46.3	27.8	14	97.7	58.7	74	149.1	89.6	34	200.6	120.5	94	252.0	151.4
55	47.1	28.3	15	98.6	59.2	75	150.0	90.1	35	201.4	121.0	95	252.9	151.9
56	48.0	28.8	16	99.4	59.7	76	150.9	90.6	36	202.3	121.5	96	253.7	152.5
57	48.9	29.4	17	100.3	60.3	77	151.7	91.2	37	203.1	122.1	97	254.6	153.0
58	49.7	29.9	18	101.1	60.8	78	152.6	91.7	38	204.0	122.6	98	255.4	153.5
59	50.6	30.4	19	102.0	61.3	79	153.4	92.2	39	204.9	123.1	99	256.3	154.0
60	51.4	30.9	20	102.9	61.8	80	154.3	92.7	40	205.7	123.6	300	257.1	154.5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

59° (121°, 239°, 301°).

Difference of Latitude and Departure for 31° (149°, 211°, 329°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	258.0	155.0	361	309.4	185.9	421	360.9	216.8	481	412.3	247.7	541	463.7	278.6
02	258.9	155.5	62	310.3	186.4	22	361.7	217.3	82	413.2	248.2	42	464.6	279.1
03	259.7	156.1	63	311.2	187.0	23	362.6	217.9	83	414.0	248.8	43	465.4	279.7
04	260.6	156.6	64	312.0	187.5	24	363.4	218.4	84	414.9	249.3	44	466.3	280.2
05	261.4	157.1	65	312.9	188.0	25	364.3	218.9	85	415.7	249.8	45	467.2	280.7
06	262.3	157.6	66	313.7	188.5	26	365.2	219.4	86	416.6	250.3	46	468.0	281.2
07	263.2	158.1	67	314.6	189.0	27	366.0	219.9	87	417.4	250.8	47	468.9	281.7
08	264.0	158.6	68	315.4	189.5	28	366.9	220.4	88	418.3	251.3	48	469.7	282.3
09	264.9	159.2	69	316.3	190.1	29	367.7	221.0	89	419.2	251.9	49	470.6	282.8
10	265.7	159.7	70	317.2	190.6	30	368.6	221.5	90	420.0	252.4	50	471.4	283.3
311	266.6	160.2	371	318.0	191.1	431	369.4	222.0	491	420.9	252.9	551	472.3	283.8
12	267.4	160.7	72	318.9	191.6	32	370.3	222.5	92	421.7	253.4	52	473.2	284.3
13	268.3	161.2	73	319.7	192.1	33	371.2	223.0	93	422.6	253.9	53	474.0	284.8
14	269.2	161.7	74	320.6	192.6	34	372.0	223.5	94	423.4	254.4	54	474.9	285.3
15	270.0	162.2	75	321.4	193.1	35	372.9	224.0	95	424.3	254.9	55	475.7	285.8
16	270.9	162.8	76	322.3	193.7	36	373.7	224.6	96	425.2	255.5	56	476.6	286.4
17	271.7	163.3	77	323.2	194.2	37	374.6	225.1	97	426.0	256.0	57	477.4	286.9
18	272.6	163.8	78	324.0	194.7	38	375.4	225.6	98	426.9	256.5	58	478.3	287.4
19	273.4	164.3	79	324.9	195.2	39	376.3	226.1	99	427.7	257.0	59	479.2	287.9
20	274.3	164.8	80	325.7	195.7	40	377.2	226.6	500	428.6	257.5	60	480.0	288.4
321	275.2	165.3	381	326.6	196.2	441	378.0	227.1	501	429.4	258.0	561	480.9	288.9
22	276.0	165.8	82	327.4	196.7	42	378.9	227.7	02	430.3	258.6	62	481.7	289.5
23	276.9	166.4	83	328.3	197.3	43	379.7	228.2	03	431.2	259.1	63	482.6	290.0
24	277.7	166.9	84	329.2	197.8	44	380.6	228.7	04	432.0	259.6	64	483.4	290.5
25	278.6	167.4	85	330.0	198.3	45	381.4	229.2	05	432.9	260.1	65	484.3	291.0
26	279.4	167.9	86	330.9	198.8	46	382.3	229.7	06	433.7	260.6	66	485.2	291.5
27	280.3	168.4	87	331.7	199.3	47	383.2	230.2	07	434.6	261.1	67	486.0	292.0
28	281.2	168.9	88	332.6	199.8	48	384.0	230.7	08	435.4	261.6	68	486.9	292.5
29	282.0	169.5	89	333.4	200.4	49	384.9	231.3	09	436.3	262.2	69	487.7	293.1
30	282.9	170.0	90	334.3	200.9	50	385.7	231.8	10	437.2	262.7	70	488.6	293.6
331	283.7	170.5	391	335.2	201.4	451	386.6	232.3	511	438.0	263.2	571	489.4	294.1
32	284.6	171.0	92	336.0	201.9	52	387.4	232.8	12	438.9	263.7	72	490.3	294.6
33	285.4	171.5	93	336.9	202.4	53	388.3	233.3	13	439.7	264.2	73	491.2	295.1
34	286.3	172.0	94	337.7	202.9	54	389.2	233.8	14	440.6	264.7	74	492.0	295.6
35	287.2	172.5	95	338.6	203.4	55	390.0	234.3	15	441.4	265.2	75	492.9	296.1
36	288.0	173.1	96	339.4	204.0	56	390.9	234.9	16	442.3	265.8	76	493.7	296.7
37	288.9	173.6	97	340.3	204.5	57	391.7	235.4	17	443.2	266.3	77	494.6	297.2
38	289.7	174.1	98	341.2	205.0	58	392.6	235.9	18	444.0	266.8	78	495.4	297.7
39	290.6	174.6	99	342.0	205.5	59	393.4	236.4	19	444.9	267.3	79	496.3	298.2
40	291.4	175.1	400	342.9	206.0	60	394.3	236.9	20	445.7	267.8	80	497.2	298.7
341	292.3	175.6	401	343.7	206.5	461	395.2	237.4	521	446.6	268.3	581	498.0	299.2
42	293.2	176.1	02	344.6	207.0	62	396.0	238.0	22	447.4	268.9	82	498.9	299.8
43	294.0	176.7	03	345.4	207.6	63	396.9	238.5	23	448.3	269.4	83	499.7	300.3
44	294.9	177.2	04	346.3	208.1	64	397.7	239.0	24	449.2	269.9	84	500.6	300.8
45	295.7	177.7	05	347.2	208.6	65	398.6	239.5	25	450.0	270.4	85	501.4	301.3
46	296.6	178.2	06	348.0	209.1	66	399.4	240.0	26	450.9	270.9	86	502.3	301.8
47	297.4	178.7	07	348.9	209.6	67	400.3	240.5	27	451.7	271.4	87	503.2	302.3
48	298.3	179.2	08	349.7	210.1	68	401.2	241.0	28	452.6	271.9	88	504.0	302.8
49	299.2	179.8	09	350.6	210.7	69	402.0	241.5	29	453.4	272.4	89	504.9	303.3
50	300.0	180.3	10	351.4	211.2	70	402.9	242.1	30	454.3	273.0	90	505.7	303.9
351	300.9	180.8	411	352.3	211.7	471	403.7	242.6	531	455.2	273.5	591	506.6	304.4
52	301.7	181.3	12	353.2	212.2	72	404.6	243.1	32	456.0	274.0	92	507.4	304.9
53	302.6	181.8	13	354.0	212.7	73	405.4	243.6	33	456.9	274.5	93	508.3	305.4
54	303.4	182.3	14	354.9	213.2	74	406.3	244.1	34	457.7	275.0	94	509.2	305.9
55	304.3	182.8	15	355.7	213.7	75	407.2	244.6	35	458.6	275.5	95	510.0	306.4
56	305.2	183.4	16	356.6	214.3	76	408.0	245.2	36	459.4	276.1	96	510.9	307.0
57	306.0	183.9	17	357.4	214.8	77	408.9	245.7	37	460.3	276.6	97	511.7	307.5
58	306.9	184.4	18	358.3	215.3	78	409.7	246.2	38	461.2	277.1	98	512.6	308.0
59	307.7	184.9	19	359.2	215.8	79	410.6	246.7	39	462.0	277.6	99	513.4	308.5
60	308.6	185.4	20	360.0	216.3	80	411.4	247.2	40	462.9	278.1	600	514.3	309.0
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

59° (121°, 239°, 301°).

TABLE 2.

Difference of Latitude and Departure for 32° (148°, 212°, 328°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	0.8	0.5	61	51.7	32.3	121	102.6	64.1	181	153.5	95.9	241	204.4	127.7
2	1.7	1.1	62	52.6	32.9	22	103.5	64.7	82	154.3	96.4	42	205.2	128.2
3	2.5	1.6	63	53.4	33.4	23	104.3	65.2	83	155.2	97.0	43	206.1	128.8
4	3.4	2.1	64	54.3	33.9	24	105.2	65.7	84	156.0	97.5	44	206.9	129.3
5	4.2	2.6	65	55.1	34.4	25	106.0	66.2	85	156.9	98.0	45	207.8	129.8
6	5.1	3.2	66	56.0	35.0	26	106.9	66.8	86	157.7	98.6	46	208.6	130.4
7	5.9	3.7	67	56.8	35.5	27	107.7	67.3	87	158.6	99.1	47	209.5	130.9
8	6.8	4.2	68	57.7	36.0	28	108.6	67.8	88	159.4	99.6	48	210.3	131.4
9	7.6	4.8	69	58.5	36.6	29	109.4	68.4	89	160.3	100.2	49	211.2	131.9
10	8.5	5.3	70	59.4	37.1	30	110.2	68.9	90	161.1	100.7	50	212.0	132.5
11	9.3	5.8	71	60.2	37.6	131	111.1	69.4	191	162.0	101.2	251	212.9	133.0
12	10.2	6.4	72	61.1	38.2	32	111.9	69.9	92	162.8	101.7	52	213.7	133.5
13	11.0	6.9	73	61.9	38.7	33	112.8	70.5	93	163.7	102.3	53	214.6	134.1
14	11.9	7.4	74	62.8	39.2	34	113.6	71.0	94	164.5	102.8	54	215.4	134.6
15	12.7	7.9	75	63.6	39.7	35	114.5	71.5	95	165.4	103.3	55	216.3	135.1
16	13.6	8.5	76	64.5	40.3	36	115.3	72.1	96	166.2	103.9	56	217.1	135.7
17	14.4	9.0	77	65.3	40.8	37	116.2	72.6	97	167.1	104.4	57	217.9	136.2
18	15.3	9.5	78	66.1	41.3	38	117.0	73.1	98	167.9	104.9	58	218.8	136.7
19	16.1	10.1	79	67.0	41.9	39	117.9	73.7	99	168.8	105.5	59	219.6	137.2
20	17.0	10.6	80	67.8	42.4	40	118.7	74.2	200	169.6	106.0	60	220.5	137.8
21	17.8	11.1	81	68.7	42.9	141	119.6	74.7	201	170.5	106.5	261	221.3	138.3
22	18.7	11.7	82	69.5	43.5	42	120.4	75.2	02	171.3	107.0	62	222.2	138.8
23	19.5	12.2	83	70.4	44.0	43	121.3	75.8	03	172.2	107.6	63	223.0	139.4
24	20.4	12.7	84	71.2	44.5	44	122.1	76.3	04	173.0	108.1	64	223.9	139.9
25	21.2	13.2	85	72.1	45.0	45	123.0	76.8	05	173.8	108.6	65	224.7	140.4
26	22.0	13.8	86	72.9	45.6	46	123.8	77.4	06	174.7	109.2	66	225.6	141.0
27	22.9	14.3	87	73.8	46.1	47	124.7	77.9	07	175.5	109.7	67	226.4	141.5
28	23.7	14.8	88	74.6	46.6	48	125.5	78.4	08	176.4	110.2	68	227.3	142.0
29	24.6	15.4	89	75.5	47.2	49	126.4	79.0	09	177.2	110.8	69	228.1	142.5
30	25.4	15.9	90	76.3	47.7	50	127.2	79.5	10	178.1	111.3	70	229.0	143.1
31	26.3	16.4	91	77.2	48.2	151	128.1	80.0	211	178.9	111.8	271	229.8	143.6
32	27.1	17.0	92	78.0	48.8	52	128.9	80.5	12	179.8	112.3	72	230.7	144.1
33	28.0	17.5	93	78.9	49.3	53	129.8	81.1	13	180.6	112.9	73	231.5	144.7
34	28.8	18.0	94	79.7	49.8	54	130.6	81.6	14	181.5	113.4	74	232.4	145.2
35	29.7	18.5	95	80.6	50.3	55	131.4	82.1	15	182.3	113.9	75	233.2	145.7
36	30.5	19.1	96	81.4	50.9	56	132.3	82.7	16	183.2	114.5	76	234.1	146.3
37	31.4	19.6	97	82.3	51.4	57	133.1	83.2	17	184.0	115.0	77	234.9	146.8
38	32.2	20.1	98	83.1	51.9	58	134.0	83.7	18	184.9	115.5	78	235.8	147.3
39	33.1	20.7	99	84.0	52.5	59	134.8	84.3	19	185.7	116.1	79	236.6	147.8
40	33.9	21.2	100	84.8	53.0	60	135.7	84.8	20	186.6	116.6	80	237.5	148.4
41	34.8	21.7	101	85.7	53.5	161	136.5	85.3	221	187.4	117.1	281	238.3	148.9
42	35.6	22.3	02	86.5	54.1	62	137.4	85.8	22	188.3	117.6	82	239.1	149.4
43	36.5	22.8	03	87.3	54.6	63	138.2	86.4	23	189.1	118.2	83	240.0	150.0
44	37.3	23.3	04	88.2	55.1	64	139.1	86.9	24	190.0	118.7	84	240.8	150.5
45	38.2	23.8	05	89.0	55.6	65	139.9	87.4	25	190.8	119.2	85	241.7	151.0
46	39.0	24.4	06	89.9	56.2	66	140.8	88.0	26	191.7	119.8	86	242.5	151.6
47	39.9	24.9	07	90.7	56.7	67	141.6	88.5	27	192.5	120.3	87	243.4	152.1
48	40.7	25.4	08	91.6	57.2	68	142.5	89.0	28	193.4	120.8	88	244.2	152.6
49	41.6	26.0	09	92.4	57.8	69	143.3	89.6	29	194.2	121.4	89	245.1	153.1
50	42.4	26.5	10	93.3	58.3	70	144.2	90.1	30	195.1	121.9	90	245.9	153.7
51	43.3	27.0	111	94.1	58.8	171	145.0	90.6	231	195.9	122.4	291	246.8	154.2
52	44.1	27.6	12	95.0	59.4	72	145.9	91.1	32	196.7	122.9	92	247.6	154.7
53	44.9	28.1	13	95.8	59.9	73	146.7	91.7	33	197.6	123.5	93	248.5	155.3
54	45.8	28.6	14	96.7	60.4	74	147.6	92.2	34	198.4	124.0	94	249.3	155.8
55	46.6	29.1	15	97.5	60.9	75	148.4	92.7	35	199.3	124.5	95	250.2	156.3
56	47.5	29.7	16	98.4	61.5	76	149.3	93.3	36	200.1	125.1	96	251.0	156.9
57	48.3	30.2	17	99.2	62.0	77	150.1	93.8	37	201.0	125.6	97	251.9	157.4
58	49.2	30.7	18	100.1	62.5	78	151.0	94.3	38	201.8	126.1	98	252.7	157.9
59	50.0	31.3	19	100.9	63.1	79	151.8	94.9	39	202.7	126.7	99	253.6	158.4
60	50.9	31.8	20	101.8	63.6	80	152.6	95.4	40	203.5	127.2	300	254.4	159.0
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

58° (122°, 238°, 302°).

TABLE 2.

Difference of Latitude and Departure for 32° (148°, 212°, 328°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	255.3	159.5	361	306.2	191.3	421	357.0	223.1	481	407.9	254.9	541	458.8	286.7
02	256.1	160.0	62	307.0	191.8	22	357.9	223.6	82	408.8	255.4	42	459.6	287.2
03	257.0	160.5	63	307.9	192.3	23	358.7	224.1	83	409.6	255.9	43	460.5	287.7
04	257.8	161.1	64	308.7	192.9	24	359.6	224.7	84	410.5	256.5	44	461.3	288.3
05	258.7	161.6	65	309.5	193.4	25	360.4	225.2	85	411.3	257.0	45	462.2	288.8
06	259.5	162.1	66	310.4	193.9	26	361.3	225.7	86	412.2	257.5	46	463.0	289.3
07	260.4	162.7	67	311.2	194.5	27	362.1	226.3	87	413.0	258.1	47	463.9	289.9
08	261.2	163.2	68	312.1	195.0	28	363.0	226.8	88	413.9	258.6	48	464.7	290.4
09	262.1	163.7	69	312.9	195.5	29	363.8	227.3	89	414.7	259.1	49	465.6	290.9
10	262.9	164.3	70	313.8	196.0	30	364.7	227.8	90	415.6	259.6	50	466.4	291.5
311	263.8	164.8	371	314.6	196.6	431	365.5	228.4	491	416.4	260.2	551	467.3	292.0
12	264.6	165.3	72	315.5	197.1	32	366.4	228.9	92	417.3	260.7	52	468.1	292.5
13	265.4	165.8	73	316.3	197.6	33	367.2	229.4	93	418.1	261.2	53	469.0	293.0
14	266.3	166.4	74	317.2	198.2	34	368.1	230.0	94	419.0	261.8	54	469.8	293.6
15	267.1	166.9	75	318.0	198.7	35	368.9	230.5	95	419.8	262.3	55	470.7	294.1
16	268.0	167.4	76	318.9	199.2	36	369.8	231.0	96	420.6	262.8	56	471.5	294.6
17	268.8	168.0	77	319.7	199.8	37	370.6	231.6	97	421.5	263.4	57	472.4	295.2
18	269.7	168.5	78	320.6	200.3	38	371.5	232.1	98	422.3	263.9	58	473.2	295.7
19	270.5	169.0	79	321.4	200.8	39	372.3	232.6	99	423.2	264.4	59	474.1	296.2
20	271.4	169.6	80	322.3	201.3	40	373.2	233.1	500	424.0	265.0	60	474.9	296.7
321	272.2	170.1	381	323.1	201.9	441	374.0	233.7	501	424.9	265.5	561	475.8	297.3
22	273.1	170.6	82	324.0	202.4	42	374.8	234.2	02	425.7	266.0	62	476.6	297.8
23	273.9	171.1	83	324.8	202.9	43	375.7	234.7	03	426.6	266.5	63	477.5	298.3
24	274.8	171.7	84	325.7	203.5	44	376.5	235.3	04	427.4	267.1	64	478.3	298.9
25	275.6	172.2	85	326.5	204.0	45	377.4	235.8	05	428.3	267.6	65	479.2	299.4
26	276.5	172.7	86	327.4	204.5	46	378.2	236.3	06	429.1	268.1	66	480.0	299.9
27	277.3	173.3	87	328.2	205.1	47	379.1	236.9	07	430.0	268.7	67	480.9	300.5
28	278.2	173.8	88	329.1	205.6	48	379.9	237.4	08	430.8	269.2	68	481.7	301.0
29	279.0	174.3	89	329.9	206.1	49	380.8	237.9	09	431.7	269.7	69	482.6	301.5
30	279.9	174.9	90	330.8	206.6	50	381.6	238.4	10	432.5	270.3	70	483.4	302.1
331	280.7	175.4	391	331.6	207.2	451	382.5	239.0	511	433.4	270.8	571	484.3	302.6
32	281.6	175.9	92	332.5	207.7	52	383.3	239.5	12	434.2	271.4	72	485.1	303.2
33	282.4	176.4	93	333.3	208.2	53	384.2	240.0	13	435.1	271.9	73	486.0	303.7
34	283.3	177.0	94	334.2	208.8	54	385.0	240.6	14	435.9	272.4	74	486.8	304.2
35	284.1	177.5	95	335.0	209.3	55	385.9	241.1	15	436.8	272.9	75	487.7	304.7
36	285.0	178.0	96	335.8	209.8	56	386.7	241.6	16	437.6	273.5	76	488.5	305.3
37	285.8	178.6	97	336.7	210.4	57	387.6	242.2	17	438.5	274.0	77	489.4	305.8
38	286.7	179.1	98	337.5	210.9	58	388.4	242.7	18	439.3	274.5	78	490.2	306.3
39	287.5	179.6	99	338.4	211.4	59	389.3	243.2	19	440.2	275.0	79	491.1	306.8
40	288.3	180.2	400	339.2	211.9	60	390.1	243.8	20	441.0	275.6	80	491.9	307.4
341	289.2	180.7	401	340.1	212.5	461	391.0	244.3	521	441.9	276.1	581	492.8	307.9
42	290.0	181.2	02	340.9	213.0	62	391.8	244.8	22	442.7	276.6	82	493.6	308.4
43	290.9	181.7	03	341.8	213.5	63	392.7	245.4	23	443.6	277.2	83	494.5	309.0
44	291.7	182.3	04	342.6	214.1	64	393.5	245.9	24	444.4	277.7	84	495.3	309.5
45	292.6	182.8	05	343.5	214.6	65	394.4	246.4	25	445.3	278.2	85	496.2	310.0
46	293.4	183.3	06	344.3	215.1	66	395.2	246.9	26	446.1	278.7	86	497.0	310.5
47	294.3	183.9	07	345.2	215.7	67	396.0	247.5	27	446.9	279.3	87	497.8	311.1
48	295.1	184.4	08	346.0	216.2	68	396.9	248.0	28	447.8	279.8	88	498.7	311.6
49	296.0	184.9	09	346.9	216.7	69	397.7	248.5	29	448.6	280.3	89	499.5	312.1
50	296.8	185.4	10	347.7	217.2	70	398.6	249.0	30	449.5	280.9	90	500.3	312.6
351	297.7	186.0	411	348.6	217.8	471	399.4	249.6	531	450.3	281.4	591	501.2	313.2
52	298.5	186.5	12	349.4	218.3	72	400.3	250.1	32	451.1	281.9	92	502.0	313.7
53	299.4	187.0	13	350.3	218.8	73	401.1	250.6	33	452.0	282.4	93	502.9	314.2
54	300.2	187.6	14	351.1	219.4	74	402.0	251.2	34	452.8	283.0	94	503.7	314.8
55	301.1	188.1	15	352.0	219.9	75	402.8	251.7	35	453.7	283.5	95	504.6	315.3
56	301.9	188.6	16	352.8	220.4	76	403.7	252.2	36	454.5	284.0	96	505.4	315.8
57	302.8	189.2	17	353.6	221.0	77	404.5	252.8	37	455.4	284.6	97	506.2	316.4
58	303.6	189.7	18	354.5	221.5	78	405.4	253.3	38	456.2	285.1	98	507.1	316.9
59	304.5	190.2	19	355.3	222.0	79	406.2	253.8	39	457.1	285.6	99	508.0	317.4
60	305.3	190.8	20	356.2	222.5	80	407.1	254.3	40	457.9	286.2	600	508.8	318.0
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

58° (122°, 238°, 302°).

TABLE 2.

Difference of Latitude and Departure for 33° (147°, 213°, 327°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	0.8	0.5	61	51.2	33.2	121	101.5	65.9	181	151.8	98.6	241	202.1	131.3
2	1.7	1.1	62	52.0	33.8	22	102.3	66.4	82	152.6	99.1	42	203.0	131.8
3	2.5	1.6	63	52.8	34.3	23	103.2	67.0	83	153.5	99.7	43	203.8	132.3
4	3.4	2.2	64	53.7	34.9	24	104.0	67.5	84	154.3	100.2	44	204.6	132.9
5	4.2	2.7	65	54.5	35.4	25	104.8	68.1	85	155.2	100.8	45	205.5	133.4
6	5.0	3.3	66	55.4	35.9	26	105.7	68.6	86	156.0	101.3	46	206.3	134.0
7	5.9	3.8	67	56.2	36.5	27	106.5	69.2	87	156.8	101.8	47	207.2	134.5
8	6.7	4.4	68	57.0	37.0	28	107.3	69.7	88	157.7	102.4	48	208.0	135.1
9	7.5	4.9	69	57.9	37.6	29	108.2	70.3	89	158.5	102.9	49	208.8	135.6
10	8.4	5.4	70	58.7	38.1	30	109.0	70.8	90	159.3	103.5	50	209.7	136.2
11	9.2	6.0	71	59.5	38.7	131	109.9	71.3	191	160.2	104.0	251	210.5	136.7
12	10.1	6.5	72	60.4	39.2	32	110.7	71.9	92	161.0	104.6	52	211.3	137.2
13	10.9	7.1	73	61.2	39.8	33	111.5	72.4	93	161.9	105.1	53	212.2	137.8
14	11.7	7.6	74	62.1	40.3	34	112.4	73.0	94	162.7	105.7	54	213.0	138.3
15	12.6	8.2	75	62.9	40.8	35	113.2	73.5	95	163.5	106.2	55	213.9	138.9
16	13.4	8.7	76	63.7	41.4	36	114.1	74.1	96	164.4	106.7	56	214.7	139.4
17	14.3	9.3	77	64.6	41.9	37	114.9	74.6	97	165.2	107.3	57	215.5	140.0
18	15.1	9.8	78	65.4	42.5	38	115.7	75.2	98	166.1	107.8	58	216.4	140.5
19	15.9	10.3	79	66.3	43.0	39	116.6	75.7	99	166.9	108.4	59	217.2	141.1
20	16.8	10.9	80	67.1	43.6	40	117.4	76.2	200	167.7	108.9	60	218.1	141.6
21	17.6	11.4	81	67.9	44.1	141	118.3	76.8	201	168.6	109.5	261	218.9	142.2
22	18.5	12.0	82	68.8	44.7	42	119.1	77.3	02	169.4	110.0	62	219.7	142.7
23	19.3	12.5	83	69.6	45.2	43	119.9	77.9	03	170.3	110.6	63	220.6	143.2
24	20.1	13.1	84	70.4	45.7	44	120.8	78.4	04	171.1	111.1	64	221.4	143.8
25	21.0	13.6	85	71.3	46.3	45	121.6	79.0	05	171.9	111.7	65	222.2	144.3
26	21.8	14.2	86	72.1	46.8	46	122.4	79.5	06	172.8	112.2	66	223.1	144.9
27	22.6	14.7	87	73.0	47.4	47	123.3	80.1	07	173.6	112.7	67	223.9	145.4
28	23.5	15.2	88	73.8	47.9	48	124.1	80.6	08	174.4	113.3	68	224.8	146.0
29	24.3	15.8	89	74.6	48.5	49	125.0	81.2	09	175.3	113.8	69	225.6	146.5
30	25.2	16.3	90	75.5	49.0	50	125.8	81.7	10	176.1	114.4	70	226.4	147.1
31	26.0	16.9	91	76.3	49.6	151	126.6	82.2	211	177.0	114.9	271	227.3	147.6
32	26.8	17.4	92	77.2	50.1	52	127.5	82.8	12	177.8	115.5	72	228.1	148.1
33	27.7	18.0	93	78.0	50.7	53	128.3	83.3	13	178.6	116.0	73	229.0	148.7
34	28.5	18.5	94	78.8	51.2	54	129.2	83.9	14	179.5	116.6	74	229.8	149.2
35	29.4	19.1	95	79.7	51.7	55	130.0	84.4	15	180.3	117.1	75	230.6	149.8
36	30.2	19.6	96	80.5	52.3	56	130.8	85.0	16	181.2	117.6	76	231.5	150.3
37	31.0	20.2	97	81.4	52.8	57	131.7	85.5	17	182.0	118.2	77	232.3	150.9
38	31.9	20.7	98	82.2	53.4	58	132.5	86.1	18	182.8	118.7	78	233.2	151.4
39	32.7	21.2	99	83.0	53.9	59	133.3	86.6	19	183.7	119.3	79	234.0	152.0
40	33.5	21.8	100	83.9	54.5	60	134.2	87.1	20	184.5	119.8	80	234.8	152.5
41	34.4	22.3	101	84.7	55.0	161	135.0	87.7	221	185.3	120.4	281	235.7	153.0
42	35.2	22.9	02	85.5	55.6	62	135.9	88.2	22	186.2	120.9	82	236.5	153.6
43	36.1	23.4	03	86.4	56.1	63	136.7	88.8	23	187.0	121.5	83	237.3	154.1
44	36.9	24.0	04	87.2	56.6	64	137.5	89.3	24	187.9	122.0	84	238.2	154.7
45	37.7	24.5	05	88.1	57.2	65	138.4	89.9	25	188.7	122.5	85	239.0	155.2
46	38.6	25.1	06	88.9	57.7	66	139.2	90.4	26	189.5	123.1	86	239.9	155.8
47	39.4	25.6	07	89.7	58.3	67	140.1	91.0	27	190.4	123.6	87	240.7	156.3
48	40.3	26.1	08	90.6	58.8	68	140.9	91.5	28	191.2	124.2	88	241.5	156.9
49	41.1	26.7	09	91.4	59.4	69	141.7	92.0	29	192.1	124.7	89	242.4	157.4
50	41.9	27.2	10	92.3	59.9	70	142.6	92.6	30	192.9	125.3	90	243.2	157.9
51	42.8	27.8	111	93.1	60.5	171	143.4	93.1	231	193.7	125.8	291	244.1	158.5
52	43.6	28.3	12	93.9	61.0	72	144.3	93.7	32	194.6	126.4	92	244.9	159.0
53	44.4	28.9	13	94.8	61.5	73	145.1	94.2	33	195.4	126.9	93	245.7	159.6
54	45.3	29.4	14	95.6	62.1	74	145.9	94.8	34	196.2	127.4	94	246.6	160.1
55	46.1	30.0	15	96.4	62.6	75	146.8	95.3	35	197.1	128.0	95	247.4	160.7
56	47.0	30.5	16	97.3	63.2	76	147.6	95.9	36	197.9	128.5	96	248.2	161.2
57	47.8	31.0	17	98.1	63.7	77	148.4	96.4	37	198.8	129.1	97	249.1	161.8
58	48.6	31.6	18	99.0	64.3	78	149.3	96.9	38	199.6	129.6	98	249.9	162.3
59	49.5	32.1	19	99.8	64.8	79	150.1	97.5	39	200.4	130.2	99	250.8	162.8
60	50.3	32.7	20	100.6	65.4	80	151.0	98.0	40	201.3	130.7	300	251.6	163.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

57° (123°, 237°, 303°).

TABLE 2.

Difference of Latitude and Departure for 33° (147°, 213°, 327°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	252.4	163.9	361	302.8	196.6	421	353.1	229.3	481	403.4	262.0	541	453.7	294.6
02	253.3	164.4	62	303.6	197.1	22	353.9	229.8	82	404.2	262.5	42	454.6	295.2
03	254.1	165.0	63	304.4	197.7	23	354.7	230.4	83	405.1	263.1	43	455.4	295.7
04	255.0	165.5	64	305.3	198.2	24	355.6	230.9	84	405.9	263.6	44	456.2	296.2
05	255.8	166.1	65	306.1	198.8	25	356.4	231.4	85	406.7	264.1	45	457.1	296.8
06	256.6	166.6	66	307.0	199.3	26	357.3	232.0	86	407.6	264.7	46	457.9	297.3
07	257.5	167.2	67	307.8	199.8	27	358.1	232.5	87	408.4	265.2	47	458.8	297.9
08	258.3	167.7	68	308.6	200.4	28	359.0	233.1	88	409.3	265.8	48	459.6	298.4
09	259.2	168.3	69	309.5	200.9	29	359.8	233.6	89	410.1	266.3	49	460.4	299.0
10	260.0	168.8	70	310.3	201.5	30	360.6	234.2	90	411.0	266.8	50	461.3	299.5
311	260.8	169.3	371	311.2	202.0	431	361.5	234.7	491	411.8	267.4	551	462.1	300.1
12	261.7	169.9	72	312.0	202.6	32	362.3	235.2	92	412.6	267.9	52	463.0	300.6
13	262.5	170.4	73	312.8	203.1	33	363.1	235.8	93	413.5	268.5	53	463.8	301.2
14	263.3	171.0	74	313.7	203.7	34	364.0	236.3	94	414.3	269.0	54	464.6	301.7
15	264.2	171.5	75	314.5	204.2	35	364.8	236.9	95	415.1	269.6	55	465.5	302.3
16	265.0	172.1	76	315.3	204.7	36	365.7	237.4	96	416.0	270.1	56	466.3	302.9
17	265.9	172.6	77	316.2	205.3	37	366.5	238.0	97	416.8	270.7	57	467.2	303.4
18	266.7	173.2	78	317.0	205.8	38	367.3	238.5	98	417.6	271.2	58	468.0	303.9
19	267.5	173.7	79	317.9	206.4	39	368.2	239.1	99	418.5	271.8	59	468.8	304.5
20	268.4	174.2	80	318.7	206.9	40	369.0	239.6	500	419.3	272.3	60	469.7	305.0
321	269.2	174.8	381	319.5	207.5	441	369.9	240.1	501	420.2	272.8	561	470.5	305.5
22	270.1	175.3	82	320.4	208.0	42	370.7	240.7	02	421.0	273.4	62	471.3	306.1
23	270.9	175.9	83	321.2	208.6	43	371.5	241.2	03	421.9	273.9	63	472.2	306.6
24	271.7	176.4	84	322.1	209.1	44	372.4	241.8	04	422.7	274.5	64	473.0	307.2
25	272.6	177.0	85	322.9	209.6	45	373.2	242.3	05	423.5	275.0	65	473.8	307.7
26	273.4	177.5	86	323.7	210.2	46	374.1	242.9	06	424.4	275.6	66	474.7	308.3
27	274.2	178.1	87	324.6	210.7	47	374.9	243.4	07	425.2	276.1	67	475.5	308.8
28	275.1	178.6	88	325.4	211.3	48	375.7	244.0	08	426.0	276.7	68	476.4	309.4
29	275.9	179.1	89	326.2	211.8	49	376.6	244.5	09	426.9	277.2	69	477.2	309.9
30	276.8	179.7	90	327.1	212.4	50	377.4	245.1	10	427.7	277.8	70	478.0	310.4
331	277.6	180.2	391	327.9	212.9	451	378.2	245.6	511	428.5	278.3	571	478.9	311.0
32	278.4	180.8	92	328.8	213.5	52	379.1	246.1	12	429.4	278.8	72	479.7	311.5
33	279.3	181.3	93	329.6	214.0	53	379.9	246.7	13	430.2	279.4	73	480.6	312.0
34	280.1	181.9	94	330.4	214.6	54	380.8	247.2	14	431.1	279.9	74	481.4	312.6
35	281.0	182.4	95	331.3	215.1	55	381.6	247.8	15	431.9	280.4	75	482.2	313.1
36	281.8	183.0	96	332.1	215.6	56	382.4	248.3	16	432.7	281.0	76	483.1	313.7
37	282.6	183.5	97	333.0	216.2	57	383.3	248.9	17	433.6	281.5	77	483.9	314.2
38	283.5	184.1	98	333.8	216.7	58	384.1	249.4	18	434.4	282.1	78	484.7	314.8
39	284.3	184.6	99	334.6	217.3	59	385.0	250.0	19	435.3	282.6	79	485.6	315.3
40	285.2	185.1	400	335.5	217.8	60	385.8	250.5	20	436.1	283.2	80	486.4	315.9
341	286.0	185.7	401	336.3	218.4	461	386.6	251.0	521	436.9	283.7	581	487.2	316.4
42	286.8	186.2	02	337.1	218.9	62	387.5	251.6	22	437.8	284.3	82	488.1	317.0
43	287.7	186.8	03	338.0	219.5	63	388.3	252.1	23	438.6	284.8	83	488.9	317.5
44	288.5	187.3	04	338.8	220.0	64	389.1	252.7	24	439.4	285.4	84	489.8	318.1
45	289.3	187.9	05	339.7	220.5	65	390.0	253.2	25	440.3	285.9	85	490.6	318.6
46	290.2	188.4	06	340.5	221.1	66	390.8	253.8	26	441.1	286.5	86	491.5	319.2
47	291.0	189.0	07	341.3	221.6	67	391.7	254.3	27	442.0	287.0	87	492.3	319.7
48	291.9	189.5	08	342.2	222.2	68	392.5	254.9	28	442.8	287.5	88	493.1	320.2
49	292.7	190.0	09	343.0	222.7	69	393.3	255.4	29	443.6	288.1	89	494.0	320.8
50	293.5	190.6	10	343.9	223.3	70	394.2	255.9	30	444.5	288.6	90	494.8	321.3
351	294.4	191.1	411	344.7	223.8	471	395.0	256.5	531	445.3	289.2	591	495.7	321.9
52	295.2	191.7	12	345.5	224.4	72	395.8	257.0	32	446.1	289.7	92	496.5	322.4
53	296.1	192.2	13	346.4	224.9	73	396.7	257.6	33	447.0	290.3	93	497.3	322.9
54	296.9	192.8	14	347.2	225.4	74	397.5	258.1	34	447.8	290.8	94	498.1	323.5
55	297.7	193.3	15	348.1	226.0	75	398.3	258.7	35	448.7	291.4	95	499.0	324.1
56	298.6	193.9	16	348.9	226.5	76	399.2	259.2	36	449.5	291.9	96	499.8	324.6
57	299.4	194.4	17	349.7	227.1	77	400.0	259.8	37	450.3	292.5	97	500.6	325.1
58	300.2	194.9	18	350.6	227.6	78	400.9	260.3	38	451.2	293.0	98	501.5	325.7
59	301.1	195.5	19	351.4	228.2	79	401.7	260.9	39	452.0	293.6	99	502.3	326.2
60	301.9	196.0	20	352.2	228.7	80	402.6	261.4	40	452.9	294.1	600	503.2	326.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

57° (123°, 237°, 303°).

TABLE 2.

Difference of Latitude and Departure for 34° (146°, 214°, 326°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	0.8	0.6	61	50.6	34.1	121	100.3	67.7	181	150.1	101.2	241	199.8	134.8
2	1.7	1.1	62	51.4	34.7	22	101.1	68.2	82	150.9	101.8	42	200.6	135.3
3	2.5	1.7	63	52.2	35.2	23	102.0	68.8	83	151.7	102.3	43	201.5	135.9
4	3.3	2.2	64	53.1	35.8	24	102.8	69.3	84	152.5	102.9	44	202.3	136.4
5	4.1	2.8	65	53.9	36.3	25	103.6	69.9	85	153.4	103.5	45	203.1	137.0
6	5.0	3.4	66	54.7	36.9	26	104.5	70.5	86	154.2	104.0	46	203.9	137.6
7	5.8	3.9	67	55.5	37.5	27	105.3	71.0	87	155.0	104.6	47	204.8	138.1
8	6.6	4.5	68	56.4	38.0	28	106.1	71.6	88	155.9	105.1	48	205.6	138.7
9	7.5	5.0	69	57.2	38.6	29	106.9	72.1	89	156.7	105.7	49	206.4	139.2
10	8.3	5.6	70	58.0	39.1	30	107.8	72.7	90	157.5	106.2	50	207.3	139.8
11	9.1	6.2	71	58.9	39.7	131	108.6	73.3	191	158.3	106.8	251	208.1	140.4
12	9.9	6.7	72	59.7	40.3	32	109.4	73.8	92	159.2	107.4	52	208.9	140.9
13	10.8	7.3	73	60.5	40.8	33	110.3	74.4	93	160.0	107.9	53	209.7	141.5
14	11.6	7.8	74	61.3	41.4	34	111.1	74.9	94	160.8	108.5	54	210.6	142.0
15	12.4	8.4	75	62.2	41.9	35	111.9	75.5	95	161.7	109.0	55	211.4	142.6
16	13.3	8.9	76	63.0	42.5	36	112.7	76.1	96	162.5	109.6	56	212.2	143.2
17	14.1	9.5	77	63.8	43.1	37	113.6	76.6	97	163.3	110.2	57	213.1	143.7
18	14.9	10.1	78	64.7	43.6	38	114.4	77.2	98	164.1	110.7	58	213.9	144.3
19	15.8	10.6	79	65.5	44.2	39	115.2	77.7	99	165.0	111.3	59	214.7	144.8
20	16.6	11.2	80	66.3	44.7	40	116.1	78.3	200	165.8	111.8	60	215.5	145.4
21	17.4	11.7	81	67.2	45.3	141	116.9	78.8	201	166.6	112.4	261	216.4	145.9
22	18.2	12.3	82	68.0	45.9	42	117.7	79.4	02	167.5	113.0	62	217.2	146.5
23	19.1	12.9	83	68.8	46.4	43	118.6	80.0	03	168.3	113.5	63	218.0	147.1
24	19.9	13.4	84	69.6	47.0	44	119.4	80.5	04	169.1	114.1	64	218.9	147.6
25	20.7	14.0	85	70.5	47.5	45	120.2	81.1	05	170.0	114.6	65	219.7	148.2
26	21.6	14.5	86	71.3	48.1	46	121.0	81.6	06	170.8	115.2	66	220.5	148.7
27	22.4	15.1	87	72.1	48.6	47	121.9	82.2	07	171.6	115.8	67	221.4	149.3
28	23.2	15.7	88	73.0	49.2	48	122.7	82.8	08	172.4	116.3	68	222.2	149.9
29	24.0	16.2	89	73.8	49.8	49	123.5	83.3	09	173.3	116.9	69	223.0	150.4
30	24.9	16.8	90	74.6	50.3	50	124.4	83.9	10	174.1	117.4	70	223.8	151.0
31	25.7	17.3	91	75.4	50.9	151	125.2	84.4	211	174.9	118.0	271	224.7	151.5
32	26.5	17.9	92	76.3	51.4	52	126.0	85.0	12	175.8	118.5	72	225.5	152.1
33	27.4	18.5	93	77.1	52.0	53	126.8	85.6	13	176.6	119.1	73	226.3	152.7
34	28.2	19.0	94	77.9	52.6	54	127.7	86.1	14	177.4	119.7	74	227.2	153.2
35	29.0	19.6	95	78.8	53.1	55	128.5	86.7	15	178.2	120.2	75	228.0	153.8
36	29.8	20.1	96	79.6	53.7	56	129.3	87.2	16	179.1	120.8	76	228.8	154.3
37	30.7	20.7	97	80.4	54.2	57	130.2	87.8	17	179.9	121.3	77	229.6	154.9
38	31.5	21.2	98	81.2	54.8	58	131.0	88.4	18	180.7	121.9	78	230.5	155.5
39	32.3	21.8	99	82.1	55.4	59	131.8	88.9	19	181.6	122.5	79	231.3	156.0
40	33.2	22.4	100	82.9	55.9	60	132.6	89.5	20	182.4	123.0	80	232.1	156.6
41	34.0	22.9	101	83.7	56.5	161	133.5	90.0	221	183.2	123.6	281	233.0	157.1
42	34.8	23.5	02	84.6	57.0	62	134.3	90.6	22	184.0	124.1	82	233.8	157.7
43	35.6	24.0	03	85.4	57.6	63	135.1	91.1	23	184.9	124.7	83	234.6	158.3
44	36.5	24.6	04	86.2	58.2	64	136.0	91.7	24	185.7	125.3	84	235.4	158.8
45	37.3	25.2	05	87.0	58.7	65	136.8	92.3	25	186.5	125.8	85	236.3	159.4
46	38.1	25.7	06	87.9	59.3	66	137.6	92.8	26	187.4	126.4	86	237.1	159.9
47	39.0	26.3	07	88.7	59.8	67	138.4	93.4	27	188.2	126.9	87	237.9	160.5
48	39.8	26.8	08	89.5	60.4	68	139.3	93.9	28	189.0	127.5	88	238.8	161.0
49	40.6	27.4	09	90.4	61.0	69	140.1	94.5	29	189.8	128.1	89	239.6	161.6
50	41.5	28.0	10	91.2	61.5	70	140.9	95.1	30	190.7	128.6	90	240.4	162.2
51	42.3	28.5	111	92.0	62.1	171	141.8	95.6	231	191.5	129.2	291	241.2	162.7
52	43.1	29.1	12	92.9	62.6	72	142.6	96.2	32	192.3	129.7	92	242.1	163.3
53	43.9	29.6	13	93.7	63.2	73	143.4	96.7	33	193.2	130.3	93	242.9	163.8
54	44.8	30.2	14	94.5	63.7	74	144.3	97.3	34	194.0	130.9	94	243.7	164.4
55	45.6	30.8	15	95.3	64.3	75	145.1	97.9	35	194.8	131.4	95	244.6	165.0
56	46.4	31.3	16	96.2	64.9	76	145.9	98.4	36	195.7	132.0	96	245.4	165.5
57	47.3	31.9	17	97.0	65.4	77	146.7	99.0	37	196.5	132.5	97	246.2	166.1
58	48.1	32.4	18	97.8	66.0	78	147.6	99.5	38	197.3	133.1	98	247.1	166.6
59	48.9	33.0	19	98.7	66.5	79	148.4	100.1	39	198.1	133.6	99	247.9	167.2
60	49.7	33.6	20	99.5	67.1	80	149.2	100.7	40	199.0	134.2	300	248.7	167.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

56° (124°, 236°, 304°).

TABLE 2.

Difference of Latitude and Departure for 34° (146°, 214°, 326°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	249.5	168.3	361	299.3	201.9	421	349.0	235.4	481	398.8	269.0	541	448.5	302.5
02	250.4	168.9	62	300.1	202.4	22	349.9	236.0	82	399.6	269.5	42	449.4	303.1
03	251.2	169.4	63	300.9	203.0	23	350.7	236.5	83	400.4	270.1	43	450.2	303.6
04	252.0	170.0	64	301.8	203.5	24	351.5	237.1	84	401.3	270.6	44	451.0	304.2
05	252.9	170.6	65	302.6	204.1	25	352.3	237.7	85	402.1	271.2	45	451.8	304.8
06	253.7	171.1	66	303.4	204.7	26	353.2	238.2	86	402.9	271.8	46	452.6	305.3
07	254.5	171.7	67	304.3	205.2	27	354.0	238.8	87	403.8	272.3	47	453.5	305.9
08	255.3	172.2	68	305.1	205.8	28	354.8	239.3	88	404.6	272.8	48	454.3	306.4
09	256.2	172.8	69	305.9	206.3	29	355.7	239.9	89	405.4	273.4	49	455.2	307.0
10	257.0	173.3	70	306.7	206.9	30	356.5	240.4	90	406.2	274.0	50	456.0	307.5
311	257.8	173.9	371	307.6	207.5	431	357.3	241.0	491	407.1	274.6	551	456.8	308.1
12	258.7	174.5	72	308.4	208.0	32	358.1	241.6	92	407.9	275.1	52	457.6	308.7
13	259.5	175.0	73	309.2	208.6	33	359.0	242.1	93	408.7	275.7	53	458.4	309.2
14	260.3	175.6	74	310.1	209.1	34	359.8	242.7	94	409.5	276.2	54	459.3	309.8
15	261.2	176.1	75	310.9	209.7	35	360.6	243.2	95	410.4	276.8	55	460.1	310.3
16	262.0	176.7	76	311.7	210.3	36	361.5	243.8	96	411.2	277.4	56	460.9	310.9
17	262.8	177.3	77	312.6	210.8	37	362.3	244.4	97	412.0	277.9	57	461.7	311.5
18	263.7	177.8	78	313.4	211.4	38	363.1	244.9	98	412.8	278.4	58	462.6	312.0
19	264.5	178.4	79	314.2	211.9	39	364.0	245.5	99	413.7	279.0	59	463.4	312.6
20	265.3	178.9	80	315.0	212.5	40	364.8	246.0	500	414.5	279.6	60	464.2	313.1
321	266.1	179.5	381	315.9	213.0	441	365.6	246.6	501	415.3	280.1	561	465.1	313.7
22	267.0	180.1	82	316.7	213.6	42	366.4	247.2	02	416.2	280.7	62	465.9	314.3
23	267.8	180.6	83	317.5	214.2	43	367.3	247.7	03	417.0	281.3	63	466.8	314.8
24	268.6	181.2	84	318.4	214.7	44	368.1	248.3	04	417.8	281.8	64	467.6	315.4
25	269.5	181.7	85	319.2	215.3	45	368.9	248.8	05	418.6	282.4	65	468.4	315.9
26	270.3	182.3	86	320.0	215.8	46	369.8	249.4	06	419.4	282.9	66	469.2	316.5
27	271.1	182.9	87	320.8	216.4	47	370.6	250.0	07	420.3	283.5	67	470.1	317.1
28	271.9	183.4	88	321.7	217.0	48	371.4	250.5	08	421.1	284.1	68	470.9	317.6
29	272.8	184.0	89	322.5	217.5	49	372.2	251.1	09	421.9	284.6	69	471.7	318.2
30	273.6	184.5	90	323.3	218.1	50	373.1	251.6	10	422.8	285.2	70	472.6	318.7
331	274.4	185.1	391	324.2	218.6	451	373.9	252.2	511	423.6	285.8	571	473.4	319.3
32	275.2	185.6	92	325.0	219.2	52	374.7	252.8	12	424.4	286.3	72	474.2	319.9
33	276.1	186.2	93	325.8	219.8	53	375.6	253.3	13	425.3	286.9	73	475.0	320.4
34	276.9	186.8	94	326.6	220.3	54	376.4	253.9	14	426.1	287.4	74	475.9	321.0
35	277.7	187.3	95	327.5	220.9	55	377.2	254.4	15	426.9	288.0	75	476.7	321.5
36	278.6	187.9	96	328.3	221.4	56	378.0	255.0	16	427.8	288.5	76	477.5	322.1
37	279.4	188.4	97	329.1	222.0	57	378.9	255.5	17	428.6	289.1	77	478.3	322.7
38	280.2	189.0	98	330.0	222.6	58	379.7	256.1	18	429.4	289.6	78	479.2	323.2
39	281.0	189.6	99	330.8	223.1	59	380.5	256.7	19	430.3	290.2	79	480.0	323.8
40	281.9	190.1	400	331.6	223.7	60	381.3	257.2	20	431.1	290.8	80	480.8	324.3
341	282.7	190.7	401	332.4	224.2	461	382.2	257.8	521	431.9	291.3	581	481.6	324.9
42	283.5	191.2	02	333.3	224.8	62	383.0	258.3	22	432.8	291.9	82	482.5	325.4
43	284.4	191.8	03	334.1	225.4	63	383.8	258.9	23	433.6	292.5	83	483.3	326.0
44	285.2	192.4	04	334.9	225.9	64	384.7	259.5	24	434.4	293.0	84	484.1	326.6
45	286.0	192.9	05	335.8	226.5	65	385.5	260.0	25	435.3	293.6	85	485.0	327.2
46	286.9	193.5	06	336.6	227.0	66	386.3	260.6	26	436.1	294.1	86	485.8	327.7
47	287.7	194.0	07	337.4	227.6	67	387.2	261.1	27	436.9	294.7	87	486.6	328.2
48	288.5	194.6	08	338.3	228.1	68	388.0	261.7	28	437.8	295.3	88	487.5	328.8
49	289.3	195.2	09	339.1	228.7	69	388.8	262.3	29	438.6	295.8	89	488.3	329.4
50	290.2	195.7	10	339.9	229.3	70	389.7	262.8	30	439.4	296.4	90	489.2	329.9
351	291.0	196.3	411	340.7	229.8	471	390.5	263.4	531	440.3	296.9	591	490.0	330.5
52	291.8	196.8	12	341.6	230.4	72	391.3	263.9	32	441.1	297.4	92	490.8	331.0
53	292.7	197.4	13	342.4	230.9	73	392.1	264.5	33	441.9	298.0	93	491.6	331.6
54	293.5	198.0	14	343.2	231.5	74	393.0	265.0	34	442.7	298.6	94	492.5	332.2
55	294.3	198.5	15	344.1	232.1	75	393.8	265.6	35	443.6	299.1	95	493.3	332.7
56	295.1	199.1	16	344.9	232.6	76	394.6	266.2	36	444.4	299.7	96	494.1	333.3
57	296.0	199.6	17	345.7	233.2	77	395.5	266.7	37	445.3	300.2	97	494.9	333.8
58	296.8	200.2	18	346.5	233.7	78	396.3	267.3	38	446.1	300.8	98	495.8	334.4
59	297.6	200.7	19	347.4	234.3	79	397.1	267.9	39	446.9	301.4	99	496.6	334.9
60	298.5	201.3	20	348.2	234.9	80	397.9	268.4	40	447.7	302.0	600	497.4	335.5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

56° (124°, 236°, 304°).

TABLE 2.

Difference of Latitude and Departure for 35° (145°, 215°, 325°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	0.8	0.6	61	50.0	35.0	121	99.1	69.4	181	148.3	103.8	241	197.4	138.2
2	1.6	1.1	62	50.8	35.6	22	99.9	70.0	82	149.1	104.4	42	198.2	138.8
3	2.5	1.7	63	51.6	36.1	23	100.8	70.5	83	149.9	105.0	43	199.1	139.4
4	3.3	2.3	64	52.4	36.7	24	101.6	71.1	84	150.7	105.5	44	199.9	140.0
5	4.1	2.9	65	53.2	37.3	25	102.4	71.7	85	151.5	106.1	45	200.7	140.5
6	4.9	3.4	66	54.1	37.9	26	103.2	72.3	86	152.4	106.7	46	201.5	141.1
7	5.7	4.0	67	54.9	38.4	27	104.0	72.8	87	153.2	107.3	47	202.3	141.7
8	6.6	4.6	68	55.7	39.0	28	104.9	73.4	88	154.0	107.8	48	203.1	142.2
9	7.4	5.2	69	56.5	39.6	29	105.7	74.0	89	154.8	108.4	49	204.0	142.8
10	8.2	5.7	70	57.3	40.2	30	106.5	74.6	90	155.6	109.0	50	204.8	143.4
11	9.0	6.3	71	58.2	40.7	131	107.3	75.1	191	156.5	109.6	251	205.6	144.0
12	9.8	6.9	72	59.0	41.3	32	108.1	75.7	92	157.3	110.1	52	206.4	144.5
13	10.6	7.5	73	59.8	41.9	33	108.9	76.3	93	158.1	110.7	53	207.2	145.1
14	11.5	8.0	74	60.6	42.4	34	109.8	76.9	94	158.9	111.3	54	208.1	145.7
15	12.3	8.6	75	61.4	43.0	35	110.6	77.4	95	159.7	111.8	55	208.9	146.3
16	13.1	9.2	76	62.3	43.6	36	111.4	78.0	96	160.6	112.4	56	209.7	146.8
17	13.9	9.8	77	63.1	44.2	37	112.2	78.6	97	161.4	113.0	57	210.5	147.4
18	14.7	10.3	78	63.9	44.7	38	113.0	79.2	98	162.2	113.6	58	211.3	148.0
19	15.6	10.9	79	64.7	45.3	39	113.9	79.7	99	163.0	114.1	59	212.2	148.6
20	16.4	11.5	80	65.5	45.9	40	114.7	80.3	200	163.8	114.7	60	213.0	149.1
21	17.2	12.0	81	66.4	46.5	141	115.5	80.9	201	164.6	115.3	261	213.8	149.7
22	18.0	12.6	82	67.2	47.0	42	116.3	81.4	02	165.5	115.9	62	214.6	150.3
23	18.8	13.2	83	68.0	47.6	43	117.1	82.0	03	166.3	116.4	63	215.4	150.9
24	19.7	13.8	84	68.8	48.2	44	118.0	82.6	04	167.1	117.0	64	216.3	151.4
25	20.5	14.3	85	69.6	48.8	45	118.8	83.2	05	167.9	117.6	65	217.1	152.0
26	21.3	14.9	86	70.4	49.3	46	119.6	83.7	06	168.7	118.2	66	217.9	152.6
27	22.1	15.5	87	71.3	49.9	47	120.4	84.3	07	169.6	118.7	67	218.7	153.1
28	22.9	16.1	88	72.1	50.5	48	121.2	84.9	08	170.4	119.3	68	219.5	153.7
29	23.8	16.6	89	72.9	51.0	49	122.1	85.5	09	171.2	119.9	69	220.4	154.3
30	24.6	17.2	90	73.7	51.6	50	122.9	86.0	10	172.0	120.5	70	221.2	154.9
31	25.4	17.8	91	74.5	52.2	151	123.7	86.6	211	172.8	121.0	271	222.0	155.4
32	26.2	18.4	92	75.4	52.8	52	124.5	87.2	12	173.7	121.6	72	222.8	156.0
33	27.0	18.9	93	76.2	53.3	53	125.3	87.8	13	174.5	122.2	73	223.6	156.6
34	27.9	19.5	94	77.0	53.9	54	126.1	88.3	14	175.3	122.7	74	224.4	157.2
35	28.7	20.1	95	77.8	54.5	55	127.0	88.9	15	176.1	123.3	75	225.3	157.7
36	29.5	20.6	96	78.6	55.1	56	127.8	89.5	16	176.9	123.9	76	226.1	158.3
37	30.3	21.2	97	79.5	55.6	57	128.6	90.1	17	177.8	124.5	77	226.9	158.9
38	31.1	21.8	98	80.3	56.2	58	129.4	90.6	18	178.6	125.0	78	227.7	159.5
39	31.9	22.4	99	81.1	56.8	59	130.2	91.2	19	179.4	125.6	79	228.5	160.0
40	32.8	22.9	100	81.9	57.4	60	131.1	91.8	20	180.2	126.2	80	229.4	160.6
41	33.6	23.5	101	82.7	57.9	161	131.9	92.3	221	181.0	126.8	281	230.2	161.2
42	34.4	24.1	02	83.6	58.5	62	132.7	92.9	22	181.9	127.3	82	231.0	161.7
43	35.2	24.7	03	84.4	59.1	63	133.5	93.5	23	182.7	127.9	83	231.8	162.3
44	36.0	25.2	04	85.2	59.7	64	134.3	94.1	24	183.5	128.5	84	232.6	162.9
45	36.9	25.8	05	86.0	60.2	65	135.2	94.6	25	184.3	129.1	85	233.5	163.5
46	37.7	26.4	06	86.8	60.8	66	136.0	95.2	26	185.1	129.6	86	234.3	164.0
47	38.5	27.0	07	87.6	61.4	67	136.8	95.8	27	185.9	130.2	87	235.1	164.6
48	39.3	27.5	08	88.5	61.9	68	137.6	96.4	28	186.8	130.8	88	235.9	165.2
49	40.1	28.1	09	89.3	62.5	69	138.4	96.9	29	187.6	131.3	89	236.7	165.8
50	41.0	28.7	10	90.1	63.1	70	139.3	97.5	30	188.4	131.9	90	237.6	166.3
51	41.8	29.3	111	90.9	63.7	171	140.1	98.1	231	189.2	132.5	291	238.4	166.9
52	42.6	29.8	12	91.7	64.2	72	140.9	98.7	32	190.0	133.1	92	239.2	167.5
53	43.4	30.4	13	92.6	64.8	73	141.7	99.2	33	190.9	133.6	93	240.0	168.1
54	44.2	31.0	14	93.4	65.4	74	142.5	99.8	34	191.7	134.2	94	240.8	168.6
55	45.1	31.5	15	94.2	66.0	75	143.4	100.4	35	192.5	134.8	95	241.6	169.2
56	45.9	32.1	16	95.0	66.5	76	144.2	100.9	36	193.3	135.4	96	242.5	169.8
57	46.7	32.7	17	95.8	67.1	77	145.0	101.5	37	194.1	135.9	97	243.3	170.4
58	47.5	33.3	18	96.7	67.7	78	145.8	102.1	38	195.0	136.5	98	244.1	170.9
59	48.3	33.8	19	97.5	68.3	79	146.6	102.7	39	195.8	137.1	99	244.9	171.5
60	49.1	34.4	20	98.3	68.8	80	147.4	103.2	40	196.6	137.7	300	245.7	172.1
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

55° (125°, 235°, 305°).

TABLE 2.

Difference of Latitude and Departure for 35° (145°, 215°, 325°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	246.6	172.6	361	295.7	207.0	421	344.9	241.5	481	394.0	275.9	541	443.2	310.3
02	247.4	173.2	62	296.5	207.6	22	345.7	242.0	82	394.8	276.4	42	444.0	310.9
03	248.2	173.8	63	297.4	208.2	23	346.5	242.6	83	395.7	277.0	43	444.8	311.4
04	249.0	174.3	64	298.2	208.8	24	347.3	243.2	84	396.5	277.6	44	445.6	312.0
05	249.9	174.9	65	299.0	209.3	25	348.1	243.8	85	397.3	278.2	45	446.4	312.6
06	250.7	175.5	66	299.8	209.9	26	349.0	244.3	86	398.1	278.7	46	447.3	313.2
07	251.5	176.1	67	300.6	210.5	27	349.8	244.9	87	398.9	279.3	47	448.1	313.7
08	252.3	176.6	68	301.5	211.1	28	350.6	245.5	88	399.8	279.9	48	448.9	314.3
09	253.1	177.2	69	302.3	211.6	29	351.4	246.0	89	400.6	280.5	49	449.7	314.9
10	253.9	177.8	70	303.1	212.2	30	352.2	246.6	90	401.4	281.0	50	450.5	315.4
311	254.8	178.4	371	303.9	212.8	431	353.1	247.2	491	402.2	281.6	551	451.4	316.0
12	255.6	178.9	72	304.7	213.4	32	353.9	247.8	92	403.0	282.2	52	452.2	316.6
13	256.4	179.5	73	305.6	213.9	33	354.7	248.3	93	403.9	282.8	53	453.0	317.2
14	257.2	180.1	74	306.4	214.5	34	355.5	248.9	94	404.7	283.3	54	453.8	317.7
15	258.0	180.7	75	307.2	215.1	35	356.3	249.5	95	405.5	283.9	55	454.6	318.3
16	258.9	181.2	76	308.0	215.6	36	357.2	250.1	96	406.3	284.5	56	455.5	318.9
17	259.7	181.8	77	308.8	216.2	37	358.0	250.6	97	407.1	285.1	57	456.3	319.5
18	260.5	182.4	78	309.6	216.8	38	358.8	251.2	98	408.0	285.6	58	457.1	320.0
19	261.3	183.0	79	310.5	217.4	39	359.6	251.8	99	408.8	286.2	59	457.9	320.6
20	262.1	183.5	80	311.3	217.9	40	360.4	252.4	500	409.6	286.8	60	458.7	321.2
321	263.0	184.1	381	312.1	218.5	441	361.3	252.9	501	410.4	287.4	561	459.6	321.8
22	263.8	184.7	82	312.9	219.1	42	362.1	253.5	02	411.2	287.9	62	460.4	322.3
23	264.6	185.2	83	313.7	219.7	43	362.9	254.1	03	412.1	288.5	63	461.2	322.9
24	265.4	185.8	84	314.6	220.2	44	363.7	254.7	04	412.9	289.1	64	462.0	323.5
25	266.2	186.4	85	315.4	220.8	45	364.5	255.2	05	413.7	289.7	65	462.8	324.1
26	267.1	187.0	86	316.2	221.4	46	365.4	255.8	06	414.5	290.2	66	463.7	324.6
27	267.9	187.5	87	317.0	222.0	47	366.2	256.4	07	415.3	290.8	67	464.5	325.2
28	268.7	188.1	88	317.8	222.5	48	367.0	256.9	08	416.1	291.4	68	465.3	325.8
29	269.5	188.7	89	318.7	223.1	49	367.8	257.5	09	417.0	291.9	69	466.1	326.4
30	270.3	189.3	90	319.5	223.7	50	368.6	258.1	10	417.8	292.5	70	466.9	326.9
331	271.1	189.8	391	320.3	224.3	451	369.4	258.7	511	418.6	293.1	571	467.8	327.5
32	272.0	190.4	92	321.1	224.8	52	370.3	259.2	12	419.4	293.7	72	468.6	328.1
33	272.8	191.0	93	321.9	225.4	53	371.1	259.8	13	420.2	294.2	73	469.4	328.7
34	273.6	191.6	94	322.8	226.0	54	371.9	260.4	14	421.1	294.8	74	470.2	329.2
35	274.4	192.1	95	323.6	226.5	55	372.7	261.0	15	421.9	295.4	75	471.0	329.8
36	275.2	192.7	96	324.4	227.1	56	373.5	261.5	16	422.7	296.0	76	471.9	330.4
37	276.1	193.3	97	325.2	227.7	57	374.4	262.1	17	423.5	296.5	77	472.7	331.0
38	276.9	193.9	98	326.0	228.3	58	375.2	262.7	18	424.3	297.1	78	473.5	331.5
39	277.7	194.4	99	326.9	228.8	59	376.0	263.3	19	425.2	297.7	79	474.3	332.1
40	278.5	195.0	400	327.7	229.4	60	376.8	263.8	20	426.0	298.3	80	475.1	332.7
341	279.3	195.6	401	328.5	230.0	461	377.6	264.4	521	426.8	298.8	581	476.0	333.3
42	280.2	196.1	02	329.3	230.6	62	378.5	265.0	22	427.6	299.4	82	476.8	333.8
43	281.0	196.7	03	330.1	231.1	63	379.3	265.5	23	428.4	300.0	83	477.6	334.4
44	281.8	197.3	04	330.9	231.7	64	380.1	266.1	24	429.3	300.5	84	478.4	335.0
45	282.6	197.9	05	331.8	232.3	65	380.9	266.7	25	430.1	301.1	85	479.2	335.6
46	283.4	198.4	06	332.6	232.9	66	381.7	267.3	26	430.9	301.7	86	480.1	336.1
47	284.3	199.0	07	333.4	233.4	67	382.6	267.8	27	431.7	302.3	87	480.9	336.7
48	285.1	199.6	08	334.2	234.0	68	383.4	268.4	28	432.5	302.8	88	481.7	337.3
49	285.9	200.2	09	335.0	234.6	69	384.2	269.0	29	433.4	303.4	89	482.5	337.9
50	286.7	200.7	10	335.9	235.1	70	385.0	269.6	30	434.2	304.0	90	483.3	338.4
351	287.5	201.3	411	336.7	235.7	471	385.8	270.1	531	435.0	304.5	591	484.2	339.0
52	288.3	201.9	12	337.5	236.3	72	386.6	270.7	32	435.8	305.1	92	485.0	339.6
53	289.2	202.5	13	338.3	236.9	73	387.5	271.3	33	436.6	305.7	93	485.8	340.2
54	290.0	203.0	14	339.1	237.4	74	388.3	271.9	34	437.5	306.3	94	486.6	340.7
55	290.8	203.6	15	340.0	238.0	75	389.1	272.4	35	438.3	306.8	95	487.4	341.3
56	291.6	204.2	16	340.8	238.6	76	389.9	273.0	36	439.1	307.4	96	488.3	341.9
57	292.4	204.7	17	341.6	239.2	77	390.7	273.6	37	439.9	308.0	97	489.1	342.5
58	293.3	205.3	18	342.4	239.7	78	391.6	274.2	38	440.7	308.6	98	489.9	343.0
59	294.1	205.9	19	343.2	240.3	79	392.4	274.7	39	441.5	309.1	99	490.7	343.6
60	294.9	206.5	20	344.1	240.9	80	393.2	275.3	40	442.3	309.7	600	491.5	344.1
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

55° (125°, 235°, 305°).

TABLE 2.

Difference of Latitude and Departure for 36° (144°, 216°, 324°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	0.8	0.6	61	49.4	35.9	121	97.9	71.1	181	146.4	106.4	241	195.0	141.7
2	1.6	1.2	62	50.2	36.4	22	98.7	71.7	82	147.2	107.0	42	195.8	142.2
3	2.4	1.8	63	51.0	37.0	23	99.5	72.3	83	148.1	107.6	43	196.6	142.8
4	3.2	2.4	64	51.8	37.6	24	100.3	72.9	84	148.9	108.2	44	197.4	143.4
5	4.0	2.9	65	52.6	38.2	25	101.1	73.5	85	149.7	108.7	45	198.2	144.0
6	4.9	3.5	66	53.4	38.8	26	101.9	74.1	86	150.5	109.3	46	199.0	144.6
7	5.7	4.1	67	54.2	39.4	27	102.7	74.6	87	151.3	109.9	47	199.8	145.2
8	6.5	4.7	68	55.0	40.0	28	103.6	75.2	88	152.1	110.5	48	200.6	145.8
9	7.3	5.3	69	55.8	40.6	29	104.4	75.8	89	152.9	111.1	49	201.4	146.4
10	8.1	5.9	70	56.6	41.1	30	105.2	76.4	90	153.7	111.7	50	202.3	146.9
11	8.9	6.5	71	57.4	41.7	131	106.0	77.0	191	154.5	112.3	251	203.1	147.5
12	9.7	7.1	72	58.2	42.3	32	106.8	77.6	92	155.3	112.9	52	203.9	148.1
13	10.5	7.6	73	59.1	42.9	33	107.6	78.2	93	156.1	113.4	53	204.7	148.7
14	11.3	8.2	74	59.9	43.5	34	108.4	78.8	94	156.9	114.0	54	205.5	149.3
15	12.1	8.8	75	60.7	44.1	35	109.2	79.4	95	157.8	114.6	55	206.3	149.9
16	12.9	9.4	76	61.5	44.7	36	110.0	79.9	96	158.6	115.2	56	207.1	150.5
17	13.8	10.0	77	62.3	45.3	37	110.8	80.5	97	159.4	115.8	57	207.9	151.1
18	14.6	10.6	78	63.1	45.8	38	111.6	81.1	98	160.2	116.4	58	208.7	151.6
19	15.4	11.2	79	63.9	46.4	39	112.5	81.7	99	161.0	117.0	59	209.5	152.2
20	16.2	11.8	80	64.7	47.0	40	113.3	82.3	200	161.8	117.6	60	210.3	152.8
21	17.0	12.3	81	65.5	47.6	141	114.1	82.9	201	162.6	118.1	261	211.2	153.4
22	17.8	12.9	82	66.3	48.2	42	114.9	83.5	02	163.4	118.7	62	212.0	154.0
23	18.6	13.5	83	67.1	48.8	43	115.7	84.1	03	164.2	119.3	63	212.8	154.6
24	19.4	14.1	84	68.0	49.4	44	116.5	84.6	04	165.0	119.9	64	213.6	155.2
25	20.2	14.7	85	68.8	50.0	45	117.3	85.2	05	165.8	120.5	65	214.4	155.8
26	21.0	15.3	86	69.6	50.5	46	118.1	85.8	06	166.7	121.1	66	215.2	156.4
27	21.8	15.9	87	70.4	51.1	47	118.9	86.4	07	167.5	121.7	67	216.0	156.9
28	22.7	16.5	88	71.2	51.7	48	119.7	87.0	08	168.3	122.3	68	216.8	157.5
29	23.5	17.0	89	72.0	52.3	49	120.5	87.6	09	169.1	122.8	69	217.6	158.1
30	24.3	17.6	90	72.8	52.9	50	121.4	88.2	10	169.9	123.4	70	218.4	158.7
31	25.1	18.2	91	73.6	53.5	151	122.2	88.8	211	170.7	124.0	271	219.2	159.3
32	25.9	18.8	92	74.4	54.1	52	123.0	89.3	12	171.5	124.6	72	220.1	159.9
33	26.7	19.4	93	75.2	54.7	53	123.8	89.9	13	172.3	125.2	73	220.9	160.5
34	27.5	20.0	94	76.0	55.3	54	124.6	90.5	14	173.1	125.8	74	221.7	161.1
35	28.3	20.6	95	76.9	55.8	55	125.4	91.1	15	173.9	126.4	75	222.5	161.6
36	29.1	21.2	96	77.7	56.4	56	126.2	91.7	16	174.7	127.0	76	223.3	162.2
37	29.9	21.7	97	78.5	57.0	57	127.0	92.3	17	175.6	127.5	77	224.1	162.8
38	30.7	22.3	98	79.3	57.6	58	127.8	92.9	18	176.4	128.1	78	224.9	163.4
39	31.6	22.9	99	80.1	58.2	59	128.6	93.5	19	177.2	128.7	79	225.7	164.0
40	32.4	23.5	100	80.9	58.8	60	129.4	94.0	20	178.0	129.3	80	226.5	164.6
41	33.2	24.1	101	81.7	59.4	161	130.3	94.6	221	178.8	129.9	281	227.3	165.2
42	34.0	24.7	02	82.5	60.0	62	131.1	95.2	22	179.6	130.5	82	228.1	165.8
43	34.8	25.3	03	83.3	60.5	63	131.9	95.8	23	180.4	131.1	83	229.0	166.3
44	35.6	25.9	04	84.1	61.1	64	132.7	96.4	24	181.2	131.7	84	229.8	166.9
45	36.4	26.5	05	84.9	61.7	65	133.5	97.0	25	182.0	132.3	85	230.6	167.5
46	37.2	27.0	06	85.8	62.3	66	134.3	97.6	26	182.8	132.8	86	231.4	168.1
47	38.0	27.6	07	86.6	62.9	67	135.1	98.2	27	183.6	133.4	87	232.2	168.7
48	38.8	28.2	08	87.4	63.5	68	135.9	98.7	28	184.5	134.0	88	233.0	169.3
49	39.6	28.8	09	88.2	64.1	69	136.7	99.3	29	185.3	134.6	89	233.8	169.9
50	40.5	29.4	10	89.0	64.7	70	137.5	99.9	30	186.1	135.2	90	234.6	170.5
51	41.3	30.0	111	89.8	65.2	171	138.3	100.5	231	186.9	135.8	291	235.4	171.0
52	42.1	30.6	12	90.6	65.8	72	139.2	101.1	32	187.7	136.4	92	236.2	171.6
53	42.9	31.2	13	91.4	66.4	73	140.0	101.7	33	188.5	137.0	93	237.0	172.2
54	43.7	31.7	14	92.2	67.0	74	140.8	102.3	34	189.3	137.5	94	237.9	172.8
55	44.5	32.3	15	93.0	67.6	75	141.6	102.9	35	190.1	138.1	95	238.7	173.4
56	45.3	32.9	16	93.8	68.2	76	142.4	103.5	36	190.9	138.7	96	239.5	174.0
57	46.1	33.5	17	94.7	68.8	77	143.2	104.0	37	191.7	139.3	97	240.3	174.6
58	46.9	34.1	18	95.5	69.4	78	144.0	104.6	38	192.5	139.9	98	241.1	175.2
59	47.7	34.7	19	96.3	69.9	79	144.8	105.2	39	193.4	140.5	99	241.9	175.7
60	48.5	35.3	20	97.1	70.5	80	145.6	105.8	40	194.2	141.1	300	242.7	176.3
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

54° (126°, 234°, 306°).

TABLE 2.

Difference of Latitude and Departure for 36° (144°, 216°, 324°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	243.5	176.9	361	292.1	212.2	421	340.6	247.5	481	389.1	282.7	541	437.7	318.0
02	244.3	177.5	62	292.9	212.8	22	341.4	248.1	82	390.0	283.3	42	438.5	318.6
03	245.1	178.1	63	293.7	213.4	23	342.2	248.6	83	390.8	283.9	43	439.3	319.1
04	246.0	178.7	64	294.5	214.0	24	343.0	249.2	84	391.6	284.5	44	440.2	319.7
05	246.8	179.3	65	295.3	214.6	25	343.8	249.8	85	392.4	285.1	45	441.0	320.3
06	247.6	179.9	66	296.1	215.1	26	344.7	250.4	86	393.2	285.6	46	441.8	320.9
07	248.4	180.5	67	296.9	215.7	27	345.5	251.0	87	394.0	286.2	47	442.6	321.5
08	249.2	181.1	68	297.7	216.3	28	346.3	251.6	88	394.8	286.8	48	443.4	322.1
09	250.0	181.6	69	298.5	216.9	29	347.1	252.2	89	395.6	287.4	49	444.2	322.7
10	250.8	182.2	70	299.3	217.5	30	347.9	252.8	90	396.4	288.0	50	445.0	323.3
311	251.6	182.8	371	300.2	218.1	431	348.7	253.3	491	397.3	288.6	551	445.8	323.8
12	252.4	183.4	72	301.0	218.7	32	349.5	253.9	92	398.1	289.2	52	446.6	324.4
13	253.2	184.0	73	301.8	219.3	33	350.3	254.5	93	398.9	289.8	53	447.4	325.0
14	254.0	184.6	74	302.6	219.8	34	351.1	255.1	94	399.7	290.3	54	448.2	325.6
15	254.9	185.2	75	303.4	220.4	35	351.9	255.7	95	400.5	290.9	55	449.0	326.2
16	255.7	185.8	76	304.2	221.0	36	352.7	256.3	96	401.3	291.5	56	449.8	326.8
17	256.5	186.4	77	305.0	221.6	37	353.6	256.9	97	402.1	292.1	57	450.7	327.4
18	257.3	186.9	78	305.8	222.2	38	354.4	257.5	98	402.9	292.7	58	451.5	328.0
19	258.1	187.5	79	306.6	222.8	39	355.2	258.0	99	403.7	293.3	59	452.3	328.5
20	258.9	188.1	80	307.4	223.4	40	356.0	258.6	500	404.5	293.9	60	453.1	329.1
321	259.7	188.7	381	308.2	224.0	441	356.8	259.2	501	405.3	294.5	561	453.9	329.7
22	260.5	189.3	82	309.1	224.5	42	357.6	259.8	02	406.1	295.0	62	454.7	330.3
23	261.3	189.9	83	309.9	225.1	43	358.4	260.4	03	407.0	295.6	63	455.5	330.9
24	262.1	190.5	84	310.7	225.7	44	359.2	261.0	04	407.8	296.2	64	456.3	331.5
25	262.9	191.0	85	311.5	226.3	45	360.0	261.6	05	408.6	296.8	65	457.1	332.1
26	263.7	191.6	86	312.3	226.9	46	360.8	262.2	06	409.4	297.4	66	457.9	332.7
27	264.6	192.2	87	313.1	227.5	47	361.6	262.8	07	410.2	298.0	67	458.7	333.3
28	265.4	192.8	88	313.9	228.1	48	362.4	263.3	08	411.0	298.6	68	459.5	333.8
29	266.2	193.4	89	314.7	228.7	49	363.3	263.9	09	411.8	299.2	69	460.3	334.4
30	267.0	194.0	90	315.5	229.2	50	364.1	264.5	10	412.6	299.8	70	461.1	335.0
331	267.8	194.6	391	316.3	229.8	451	364.9	265.1	511	413.4	300.3	571	462.0	335.6
32	268.6	195.2	92	317.1	230.4	52	365.7	265.7	12	414.2	300.9	72	462.8	336.2
33	269.4	195.7	93	318.0	231.0	53	366.5	266.3	13	415.1	301.5	73	463.6	336.8
34	270.2	196.3	94	318.8	231.6	54	367.3	266.9	14	415.9	302.1	74	464.4	337.4
35	271.0	196.9	95	319.6	232.2	55	368.1	267.5	15	416.7	302.7	75	465.2	338.0
36	271.8	197.5	96	320.4	232.8	56	368.9	268.0	16	417.5	303.3	76	466.0	338.5
37	272.6	198.1	97	321.2	233.4	57	369.7	268.6	17	418.3	303.9	77	466.8	339.1
38	273.5	198.7	98	322.0	233.9	58	370.5	269.2	18	419.1	304.4	78	467.6	339.7
39	274.3	199.3	99	322.8	234.5	59	371.3	269.8	19	419.9	305.0	79	468.4	340.3
40	275.1	199.9	400	323.6	235.1	60	372.2	270.4	20	420.7	305.6	80	469.3	340.9
341	275.9	200.4	401	324.4	235.7	461	373.0	271.0	521	421.5	306.2	581	470.1	341.5
42	276.7	201.0	02	325.2	236.3	62	373.8	271.6	22	422.3	306.8	82	470.9	342.1
43	277.5	201.6	03	326.0	236.9	63	374.6	272.2	23	423.1	307.4	83	471.7	342.7
44	278.3	202.2	04	326.9	237.5	64	375.4	272.7	24	423.9	308.0	84	472.5	343.2
45	279.1	202.8	05	327.7	238.1	65	376.2	273.3	25	424.7	308.6	85	473.3	343.8
46	279.9	203.4	06	328.5	238.7	66	377.0	273.9	26	425.5	309.2	86	474.1	344.4
47	280.7	204.0	07	329.3	239.2	67	377.8	274.5	27	426.4	309.7	87	474.9	345.0
48	281.5	204.6	08	330.1	239.8	68	378.6	275.1	28	427.2	310.3	88	475.7	345.6
49	282.4	205.1	09	330.9	240.4	69	379.4	275.7	29	428.0	310.9	89	476.5	346.2
50	283.2	205.7	10	331.7	241.0	70	380.2	276.3	30	428.8	311.5	90	477.3	346.8
351	284.0	206.3	411	332.5	241.6	471	381.1	276.9	531	429.6	312.1	591	478.2	347.4
52	284.8	206.9	12	333.3	242.2	72	381.9	277.4	32	430.4	312.7	92	479.0	347.9
53	285.6	207.5	13	334.1	242.8	73	382.7	278.0	33	431.2	313.3	93	479.8	348.5
54	286.4	208.1	14	334.9	243.4	74	383.5	278.6	34	432.0	313.9	94	480.6	349.1
55	287.2	208.7	15	335.8	243.9	75	384.3	279.2	35	432.9	314.4	95	481.4	349.7
56	288.0	209.3	16	336.6	244.5	76	385.1	279.8	36	433.7	315.0	96	482.2	350.3
57	288.8	209.8	17	337.4	245.1	77	385.9	280.4	37	434.5	315.6	97	483.0	350.9
58	289.6	210.4	18	338.2	245.7	78	386.7	281.0	38	435.3	316.2	98	483.8	351.5
59	290.4	211.0	19	339.0	246.3	79	387.5	281.6	39	436.1	316.8	99	484.6	352.1
60	291.3	211.6	20	339.8	246.9	80	388.3	282.1	40	436.9	317.4	600	485.4	352.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

54° (126°, 234°, 306°).

TABLE 2.

Difference of Latitude and Departure for 37° (143°, 217°, 323°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	0.8	0.6	61	48.7	36.7	121	96.6	72.8	181	144.6	108.9	241	192.5	145.0
2	1.6	1.2	62	49.5	37.3	22	97.4	73.4	82	145.4	109.5	42	193.3	145.6
3	2.4	1.8	63	50.3	37.9	23	98.2	74.0	83	146.2	110.1	43	194.1	146.2
4	3.2	2.4	64	51.1	38.5	24	99.0	74.6	84	146.9	110.7	44	194.9	146.8
5	4.0	3.0	65	51.9	39.1	25	99.8	75.2	85	147.7	111.3	45	195.7	147.4
6	4.8	3.6	66	52.7	39.7	26	100.6	75.8	86	148.5	111.9	46	196.5	148.0
7	5.6	4.2	67	53.5	40.3	27	101.4	76.4	87	149.3	112.5	47	197.3	148.6
8	6.4	4.8	68	54.3	40.9	28	102.2	77.0	88	150.1	113.1	48	198.1	149.3
9	7.2	5.4	69	55.1	41.5	29	103.0	77.6	89	150.9	113.7	49	198.9	149.9
10	8.0	6.0	70	55.9	42.1	30	103.8	78.2	90	151.7	114.3	50	199.7	150.5
11	8.8	6.6	71	56.7	42.7	131	104.6	78.8	191	152.5	114.9	251	200.5	151.1
12	9.6	7.2	72	57.5	43.3	32	105.4	79.4	92	153.3	115.5	52	201.3	151.7
13	10.4	7.8	73	58.3	43.9	33	106.2	80.0	93	154.1	116.2	53	202.1	152.3
14	11.2	8.4	74	59.1	44.5	34	107.0	80.6	94	154.9	116.8	54	202.9	152.9
15	12.0	9.0	75	59.9	45.1	35	107.8	81.2	95	155.7	117.4	55	203.7	153.5
16	12.8	9.6	76	60.7	45.7	36	108.6	81.8	96	156.5	118.0	56	204.5	154.1
17	13.6	10.2	77	61.5	46.3	37	109.4	82.4	97	157.3	118.6	57	205.2	154.7
18	14.4	10.8	78	62.3	46.9	38	110.2	83.1	98	158.1	119.2	58	206.0	155.3
19	15.2	11.4	79	63.1	47.5	39	111.0	83.7	99	158.9	119.8	59	206.8	155.9
20	16.0	12.0	80	63.9	48.1	40	111.8	84.3	200	159.7	120.4	60	207.6	156.5
21	16.8	12.6	81	64.7	48.7	141	112.6	84.9	201	160.5	121.0	261	208.4	157.1
22	17.6	13.2	82	65.5	49.3	42	113.4	85.5	02	161.3	121.6	62	209.2	157.7
23	18.4	13.8	83	66.3	50.0	43	114.2	86.1	03	162.1	122.2	63	210.0	158.3
24	19.2	14.4	84	67.1	50.6	44	115.0	86.7	04	162.9	122.8	64	210.8	158.9
25	20.0	15.0	85	67.9	51.2	45	115.8	87.3	05	163.7	123.4	65	211.6	159.5
26	20.8	15.6	86	68.7	51.8	46	116.6	87.9	06	164.5	124.0	66	212.4	160.1
27	21.6	16.2	87	69.5	52.4	47	117.4	88.5	07	165.3	124.6	67	213.2	160.7
28	22.4	16.9	88	70.3	53.0	48	118.2	89.1	08	166.1	125.2	68	214.0	161.3
29	23.2	17.5	89	71.1	53.6	49	119.0	89.7	09	166.9	125.8	69	214.8	161.9
30	24.0	18.1	90	71.9	54.2	50	119.8	90.3	10	167.7	126.4	70	215.6	162.5
31	24.8	18.7	91	72.7	54.8	151	120.6	90.9	211	168.5	127.0	271	216.4	163.1
32	25.6	19.3	92	73.5	55.4	52	121.4	91.5	12	169.3	127.6	72	217.2	163.7
33	26.4	19.9	93	74.3	56.0	53	122.2	92.1	13	170.1	128.2	73	218.0	164.3
34	27.2	20.5	94	75.1	56.6	54	123.0	92.7	14	170.9	128.8	74	218.8	164.9
35	28.0	21.1	95	75.9	57.2	55	123.8	93.3	15	171.7	129.4	75	219.6	165.5
36	28.8	21.7	96	76.7	57.8	56	124.6	93.9	16	172.5	130.0	76	220.4	166.1
37	29.5	22.3	97	77.5	58.4	57	125.4	94.5	17	173.3	130.6	77	221.2	166.7
38	30.3	22.9	98	78.3	59.0	58	126.2	95.1	18	174.1	131.2	78	222.0	167.3
39	31.1	23.5	99	79.1	59.6	59	127.0	95.7	19	174.9	131.8	79	222.8	167.9
40	31.9	24.1	100	79.9	60.2	60	127.8	96.3	20	175.7	132.4	80	223.6	168.5
41	32.7	24.7	101	80.7	60.8	161	128.6	96.9	221	176.5	133.0	281	224.4	169.1
42	33.5	25.3	02	81.5	61.4	62	129.4	97.5	22	177.3	133.6	82	225.2	169.7
43	34.3	25.9	03	82.3	62.0	63	130.2	98.1	23	178.1	134.2	83	226.0	170.3
44	35.1	26.5	04	83.1	62.6	64	131.0	98.7	24	178.9	134.8	84	226.8	170.9
45	35.9	27.1	05	83.9	63.2	65	131.8	99.3	25	179.7	135.4	85	227.6	171.5
46	36.7	27.7	06	84.7	63.8	66	132.6	99.9	26	180.5	136.0	86	228.4	172.1
47	37.5	28.3	07	85.5	64.4	67	133.4	100.5	27	181.3	136.6	87	229.2	172.7
48	38.3	28.9	08	86.3	65.0	68	134.2	101.1	28	182.1	137.2	88	230.0	173.3
49	39.1	29.5	09	87.1	65.6	69	135.0	101.7	29	182.9	137.8	89	230.8	173.9
50	39.9	30.1	10	87.8	66.2	70	135.8	102.3	30	183.7	138.4	90	231.6	174.5
51	40.7	30.7	111	88.6	66.8	171	136.6	102.9	231	184.5	139.0	291	232.4	175.1
52	41.5	31.3	12	89.4	67.4	72	137.4	103.5	32	185.3	139.6	92	233.2	175.7
53	42.3	31.9	13	90.2	68.0	73	138.2	104.1	33	186.1	140.2	93	234.0	176.3
54	43.1	32.5	14	91.0	68.6	74	139.0	104.7	34	186.9	140.8	94	234.8	176.9
55	43.9	33.1	15	91.8	69.2	75	139.8	105.3	35	187.7	141.4	95	235.6	177.5
56	44.7	33.7	16	92.6	69.8	76	140.6	105.9	36	188.5	142.0	96	236.4	178.1
57	45.5	34.3	17	93.4	70.4	77	141.4	106.5	37	189.3	142.6	97	237.2	178.7
58	46.3	34.9	18	94.2	71.0	78	142.2	107.1	38	190.1	143.2	98	238.0	179.3
59	47.1	35.5	19	95.0	71.6	79	143.0	107.7	39	190.9	143.8	99	238.8	179.9
60	47.9	36.1	20	95.8	72.2	80	143.8	108.3	40	191.7	144.4	300	239.6	180.5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

53° (127°, 233°, 307°).

TABLE 2.

Difference of Latitude and Departure for 37° (143°, 217°, 323°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	240.4	181.1	361	288.3	217.3	421	336.2	253.4	481	384.1	289.5	541	432.0	325.6
02	241.2	181.7	62	289.1	217.9	22	337.0	254.0	82	384.9	290.0	42	432.8	326.2
03	242.0	182.4	63	289.9	218.5	23	337.8	254.6	83	385.7	290.6	43	433.6	326.8
04	242.7	183.0	64	290.7	219.1	24	338.6	255.2	84	386.5	291.2	44	434.4	327.3
05	243.5	183.6	65	291.5	219.7	25	339.4	255.8	85	387.3	291.8	45	435.2	327.9
06	244.3	184.2	66	292.3	220.3	26	340.2	256.4	86	388.1	292.4	46	436.0	328.5
07	245.1	184.8	67	293.1	220.9	27	341.0	257.0	87	388.9	293.0	47	436.8	329.1
08	245.9	185.4	68	293.9	221.5	28	341.8	257.6	88	389.7	293.6	48	437.6	329.7
09	246.7	186.0	69	294.7	222.1	29	342.6	258.2	89	390.5	294.2	49	438.4	330.3
10	247.5	186.6	70	295.5	222.7	30	343.4	258.8	90	391.3	294.8	50	439.2	330.9
311	248.3	187.2	371	296.3	223.3	431	344.2	259.4	491	392.1	295.4	551	440.0	331.5
12	249.1	187.8	72	297.1	223.9	32	345.0	260.0	92	392.9	296.0	52	440.8	332.1
13	249.9	188.4	73	297.9	224.5	33	345.8	260.6	93	393.7	296.6	53	441.6	332.7
14	250.7	189.0	74	298.7	225.1	34	346.6	261.2	94	394.5	297.2	54	442.4	333.3
15	251.5	189.6	75	299.5	225.7	35	347.4	261.8	95	395.3	297.8	55	443.2	333.9
16	252.3	190.2	76	300.3	226.3	36	348.2	262.4	96	396.1	298.5	56	444.0	334.6
17	253.1	190.8	77	301.1	226.9	37	349.0	263.0	97	396.9	299.1	57	444.8	235.2
18	253.9	191.4	78	301.8	227.5	38	349.8	263.6	98	397.7	299.7	58	445.6	335.8
19	254.7	192.0	79	302.6	228.1	39	350.6	264.2	99	398.5	300.3	59	446.4	336.4
20	255.5	192.6	80	303.4	228.7	40	351.4	264.8	500	399.3	300.9	60	447.2	337.0
321	256.3	193.2	381	304.2	229.3	441	352.2	265.4	501	400.1	301.5	561	448.0	337.6
22	257.1	193.8	82	305.0	229.9	42	353.0	266.0	02	400.9	302.1	62	448.8	338.2
23	257.9	194.4	83	305.8	230.5	43	353.8	266.6	03	401.7	302.7	63	449.6	338.8
24	258.7	195.0	84	306.6	231.1	44	354.6	267.2	04	402.5	303.3	64	450.4	339.4
25	259.5	195.6	85	307.4	231.7	45	355.4	267.8	05	403.3	303.9	65	451.2	340.0
26	260.3	196.2	86	308.2	232.3	46	356.2	268.4	06	404.1	304.5	66	452.0	340.6
27	261.1	196.8	87	309.0	232.9	47	357.0	269.0	07	404.9	305.1	67	452.8	341.2
28	261.9	197.4	88	309.8	233.5	48	357.8	269.6	08	405.7	305.7	68	453.6	341.8
29	262.7	198.0	89	310.6	234.1	49	358.6	270.2	09	406.5	306.3	69	454.4	342.4
30	263.5	198.6	90	311.4	234.7	50	359.4	270.8	10	407.3	306.9	70	455.2	343.0
331	264.3	199.2	391	312.2	235.3	451	360.1	271.4	511	408.1	307.5	571	456.0	343.6
32	265.1	199.8	92	313.0	235.9	52	360.9	272.0	12	408.9	308.2	72	456.8	344.3
33	265.9	200.4	93	313.8	236.5	53	361.7	272.6	13	409.7	308.8	73	457.6	344.9
34	266.7	201.0	94	314.6	237.1	54	362.5	273.2	14	410.5	309.4	74	458.4	345.5
35	267.5	201.6	95	315.4	237.7	55	363.3	273.8	15	411.3	310.0	75	459.2	346.1
36	268.3	202.2	96	316.2	238.3	56	364.1	274.4	16	412.1	310.6	76	460.0	346.7
37	269.1	202.8	97	317.0	238.9	57	364.9	275.0	17	412.9	311.2	77	460.8	347.3
38	269.9	203.4	98	317.8	239.5	58	365.7	275.6	18	413.7	311.8	78	461.6	347.9
39	270.7	204.0	99	318.6	240.1	59	366.5	276.2	19	414.5	312.4	79	462.4	348.5
40	271.5	204.6	400	319.4	240.7	60	367.3	276.8	20	415.3	313.0	80	463.2	349.1
341	272.3	205.2	401	320.2	241.3	461	368.1	277.4	521	416.1	313.6	581	464.0	349.7
42	273.1	205.8	02	321.0	241.9	62	368.9	278.0	22	416.9	314.2	82	464.8	350.3
43	273.9	206.4	03	321.8	242.5	63	369.7	278.6	23	417.7	314.8	83	465.6	350.9
44	274.7	207.0	04	322.6	243.1	64	370.5	279.2	24	418.5	315.4	84	466.4	351.5
45	275.5	207.6	05	323.4	243.7	65	371.3	279.8	25	419.3	316.0	85	467.2	352.1
46	276.3	208.2	06	324.2	244.3	66	372.1	280.4	26	420.1	316.6	86	468.0	352.7
47	277.1	208.8	07	325.0	244.9	67	372.9	281.0	27	420.9	317.2	87	468.8	353.3
48	277.9	209.4	08	325.8	245.5	68	373.7	281.6	28	421.7	317.8	88	469.6	353.9
49	278.7	210.0	09	326.6	246.1	69	374.5	282.3	29	422.5	318.4	89	470.4	354.5
50	279.5	210.6	10	327.4	246.7	70	375.3	282.9	30	423.3	319.0	90	471.2	355.1
351	280.3	211.2	411	328.2	247.3	471	376.1	283.5	531	424.1	319.6	591	472.0	355.7
52	281.1	211.8	12	329.0	247.9	72	376.9	284.1	32	424.9	320.2	92	472.8	356.3
53	281.9	212.4	13	329.8	248.5	73	377.7	284.7	33	425.7	320.8	93	473.6	356.9
54	282.7	213.0	14	330.6	249.2	74	378.5	285.3	34	426.5	321.4	94	474.4	357.5
55	283.5	213.6	15	331.4	249.8	75	379.3	285.9	35	427.3	322.0	95	475.2	358.1
56	284.3	214.2	16	332.2	250.4	76	380.1	286.5	36	428.1	322.6	96	476.0	358.7
57	285.1	214.8	17	333.0	251.0	77	380.9	287.1	37	428.9	323.2	97	476.8	359.3
58	285.9	215.4	18	333.8	251.6	78	381.7	287.7	38	429.7	323.8	98	477.6	359.9
59	286.7	216.1	19	334.6	252.2	79	382.5	288.3	39	430.5	324.4	99	478.4	360.5
60	287.5	216.7	20	335.4	252.8	80	383.3	288.9	40	431.3	325.0	600	479.2	361.1
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

53° (127°, 233°, 307°).

TABLE 2.

Difference of Latitude and Departure for 38° (142°, 218°, 322°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	0.8	0.6	61	48.1	37.6	121	95.3	74.5	181	142.6	111.4	241	189.9	148.4
2	1.6	1.2	62	48.9	38.2	22	96.1	75.1	82	143.4	112.1	42	190.7	149.0
3	2.4	1.8	63	49.6	38.8	23	96.9	75.7	83	144.2	112.7	43	191.5	149.6
4	3.2	2.5	64	50.4	39.4	24	97.7	76.3	84	145.0	113.3	44	192.3	150.2
5	3.9	3.1	65	51.2	40.0	25	98.5	77.0	85	145.8	113.9	45	193.1	150.8
6	4.7	3.7	66	52.0	40.6	26	99.3	77.6	86	146.6	114.5	46	193.9	151.5
7	5.5	4.3	67	52.8	41.2	27	100.1	78.2	87	147.4	115.1	47	194.6	152.1
8	6.3	4.9	68	53.6	41.9	28	100.9	78.8	88	148.1	115.7	48	195.4	152.7
9	7.1	5.5	69	54.4	42.5	29	101.7	79.4	89	148.9	116.4	49	196.2	153.3
10	7.9	6.2	70	55.2	43.1	30	102.4	80.0	90	149.7	117.0	50	197.0	153.9
11	8.7	6.8	71	55.9	43.7	131	103.2	80.7	191	150.5	117.6	251	197.8	154.5
12	9.5	7.4	72	56.7	44.3	32	104.0	81.3	92	151.3	118.2	52	198.6	155.1
13	10.2	8.0	73	57.5	44.9	33	104.8	81.9	93	152.1	118.8	53	199.4	155.8
14	11.0	8.6	74	58.3	45.6	34	105.6	82.5	94	152.9	119.4	54	200.2	156.4
15	11.8	9.2	75	59.1	46.2	35	106.4	83.1	95	153.7	120.1	55	200.9	157.0
16	12.6	9.9	76	59.9	46.8	36	107.2	83.7	96	154.5	120.7	56	201.7	157.6
17	13.4	10.5	77	60.7	47.4	37	108.0	84.3	97	155.2	121.3	57	202.5	158.2
18	14.2	11.1	78	61.5	48.0	38	108.7	85.0	98	156.0	121.9	58	203.3	158.8
19	15.0	11.7	79	62.3	48.6	39	109.5	85.6	99	156.8	122.5	59	204.1	159.5
20	15.8	12.3	80	63.0	49.3	40	110.3	86.2	200	157.6	123.1	60	204.9	160.1
21	16.5	12.9	81	63.8	49.9	141	111.1	86.8	201	158.4	123.7	261	205.7	160.7
22	17.3	13.5	82	64.6	50.5	42	111.9	87.4	02	159.2	124.4	62	206.5	161.3
23	18.1	14.2	83	65.4	51.1	43	112.7	88.0	03	160.0	125.0	63	207.2	161.9
24	18.9	14.8	84	66.2	51.7	44	113.5	88.7	04	160.8	125.6	64	208.0	162.5
25	19.7	15.4	85	67.0	52.3	45	114.3	89.3	05	161.5	126.2	65	208.8	163.2
26	20.5	16.0	86	67.8	52.9	46	115.0	89.9	06	162.3	126.8	66	209.6	163.8
27	21.3	16.6	87	68.6	53.6	47	115.8	90.5	07	163.1	127.4	67	210.4	164.4
28	22.1	17.2	88	69.3	54.2	48	116.6	91.1	08	163.9	128.1	68	211.2	165.0
29	22.9	17.9	89	70.1	54.8	49	117.4	91.7	09	164.7	128.7	69	212.0	165.6
30	23.6	18.5	90	70.9	55.4	50	118.2	92.3	10	165.5	129.3	70	212.8	166.2
31	24.4	19.1	91	71.7	56.0	151	119.0	93.0	211	166.3	129.9	271	213.6	166.8
32	25.2	19.7	92	72.5	56.6	52	119.8	93.6	12	167.1	130.5	72	214.3	167.5
33	26.0	20.3	93	73.3	57.3	53	120.6	94.2	13	167.8	131.1	73	215.1	168.1
34	26.8	20.9	94	74.1	57.9	54	121.4	94.8	14	168.6	131.8	74	215.9	168.7
35	27.6	21.5	95	74.9	58.5	55	122.1	95.4	15	169.4	132.4	75	216.7	169.3
36	28.4	22.2	96	75.6	59.1	56	122.9	96.0	16	170.2	133.0	76	217.5	169.9
37	29.2	22.8	97	76.4	59.7	57	123.7	96.7	17	171.0	133.6	77	218.3	170.5
38	29.9	23.4	98	77.2	60.3	58	124.5	97.3	18	171.8	134.2	78	219.1	171.2
39	30.7	24.0	99	78.0	61.0	59	125.3	97.9	19	172.6	134.8	79	219.9	171.8
40	31.5	24.6	100	78.8	61.6	60	126.1	98.5	20	173.4	135.4	80	220.6	172.4
41	32.3	25.2	101	79.6	62.2	161	126.9	99.1	221	174.2	136.1	281	221.4	173.0
42	33.1	25.9	02	80.4	62.8	62	127.7	99.7	22	174.9	136.7	82	222.2	173.6
43	33.9	26.5	03	81.2	63.4	63	128.4	100.4	23	175.7	137.3	83	223.0	174.2
44	34.7	27.1	04	82.0	64.0	64	129.2	101.0	24	176.5	137.9	84	223.8	174.8
45	35.5	27.7	05	82.7	64.6	65	130.0	101.6	25	177.3	138.5	85	224.6	175.5
46	36.2	28.3	06	83.5	65.3	66	130.8	102.2	26	178.1	139.1	86	225.4	176.1
47	37.0	28.9	07	84.3	65.9	67	131.6	102.8	27	178.9	139.8	87	226.2	176.7
48	37.8	29.6	08	85.1	66.5	68	132.4	103.4	28	179.7	140.4	88	226.9	177.3
49	38.6	30.2	09	85.9	67.1	69	133.2	104.0	29	180.5	141.0	89	227.7	177.9
50	39.4	30.8	10	86.7	67.7	70	134.0	104.7	30	181.2	141.6	90	228.5	178.5
51	40.2	31.4	111	87.5	68.3	171	134.7	105.3	231	182.0	142.2	291	229.3	179.2
52	41.0	32.0	12	88.3	69.0	72	135.5	105.9	32	182.8	142.8	92	230.1	179.8
53	41.8	32.6	13	89.0	69.6	73	136.3	106.5	33	183.6	143.4	93	230.9	180.4
54	42.6	33.2	14	89.8	70.2	74	137.1	107.1	34	184.4	144.1	94	231.7	181.0
55	43.3	33.9	15	90.6	70.8	75	137.9	107.7	35	185.2	144.7	95	232.5	181.6
56	44.1	34.5	16	91.4	71.4	76	138.7	108.4	36	186.0	145.3	96	233.3	182.2
57	44.9	35.1	17	92.2	72.0	77	139.5	109.0	37	186.8	145.9	97	234.0	182.9
58	45.7	35.7	18	93.0	72.6	78	140.3	109.6	38	187.5	146.5	98	234.8	183.5
59	46.5	36.3	19	93.8	73.3	79	141.1	110.2	39	188.3	147.1	99	235.6	184.1
60	47.3	36.9	20	94.6	73.9	80	141.8	110.8	40	189.1	147.8	300	236.4	184.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

52° (128°, 232°, 308°).

TABLE 2.

Difference of Latitude and Departure for 38° (142°, 218°, 322°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	237.2	185.3	361	284.5	222.3	421	331.8	259.2	481	379.0	296.2	541	426.3	333.1
02	238.0	185.9	62	285.3	222.9	22	332.5	259.8	82	379.8	296.8	42	427.1	333.7
03	238.8	186.6	63	286.0	223.5	23	333.3	260.4	83	380.6	297.4	43	427.9	334.3
04	239.6	187.2	64	286.8	224.1	24	334.1	261.0	84	381.4	298.0	44	428.7	335.0
05	240.3	187.8	65	287.6	224.7	25	334.9	261.7	85	382.2	298.6	45	429.5	335.6
06	241.1	188.4	66	288.4	225.3	26	335.7	262.3	86	383.0	299.2	46	430.3	336.2
07	241.9	189.0	67	289.2	226.0	27	336.5	262.9	87	383.8	299.8	47	431.0	336.8
08	242.7	189.6	68	290.0	226.6	28	337.3	263.5	88	384.5	300.4	48	431.8	337.4
09	243.5	190.2	69	290.8	227.2	29	338.1	264.1	89	385.3	301.1	49	432.6	338.0
10	244.3	190.9	70	291.6	227.8	30	338.8	264.7	90	386.1	301.7	50	433.4	338.6
311	245.1	191.5	371	292.4	228.4	431	339.6	265.4	491	386.9	302.3	551	434.2	339.3
12	245.9	192.1	72	293.1	229.0	32	340.4	266.0	92	387.7	302.9	52	435.0	339.9
13	246.6	192.7	73	293.9	229.6	33	341.2	266.6	93	388.5	303.5	53	435.8	340.5
14	247.4	193.3	74	294.7	230.3	34	342.0	267.2	94	389.3	304.2	54	436.6	341.1
15	248.2	193.9	75	295.5	230.9	35	342.8	267.8	95	390.1	304.8	55	437.4	341.7
16	249.0	194.6	76	296.3	231.5	36	343.6	268.4	96	390.9	305.4	56	438.1	342.3
17	249.8	195.2	77	297.1	232.1	37	344.4	269.1	97	391.6	306.0	57	438.9	343.0
18	250.6	195.8	78	297.9	232.7	38	345.2	269.7	98	392.4	306.6	58	439.7	343.6
19	251.4	196.4	79	298.7	233.3	39	345.9	270.3	99	393.2	307.2	59	440.5	344.2
20	252.2	197.0	80	299.4	234.0	40	346.7	270.9	500	394.0	307.8	60	441.3	344.8
321	253.0	197.6	381	300.2	234.6	441	347.5	271.5	501	394.8	308.4	561	442.1	345.4
22	253.7	198.2	82	301.0	235.2	42	348.3	272.1	02	395.6	309.1	62	442.9	346.0
23	254.5	198.9	83	301.8	235.8	43	349.1	272.7	03	396.4	309.7	63	443.7	346.6
24	255.3	199.5	84	302.6	236.4	44	349.9	273.4	04	397.2	310.3	64	444.4	347.2
25	256.1	200.1	85	303.4	237.0	45	350.7	274.0	05	397.9	310.9	65	445.2	347.8
26	256.9	200.7	86	304.2	237.7	46	351.5	274.6	06	398.7	311.6	66	446.0	348.5
27	257.7	201.3	87	305.0	238.3	47	352.2	275.2	07	399.5	312.2	67	446.8	349.1
28	258.5	201.9	88	305.7	238.9	48	353.0	275.8	08	400.3	312.8	68	447.6	349.7
29	259.3	202.6	89	306.5	239.5	49	353.8	276.4	09	401.1	313.4	69	448.4	350.3
30	260.0	203.2	90	307.3	240.1	50	354.6	277.1	10	401.9	314.0	70	449.2	350.9
331	260.8	203.8	391	308.1	240.7	451	355.4	277.7	511	402.7	314.6	571	450.0	351.6
32	261.6	204.4	92	308.9	241.3	52	356.2	278.3	12	403.5	315.2	72	450.7	352.2
33	262.4	205.0	93	309.7	242.0	53	357.0	278.9	13	404.2	315.8	73	451.5	352.8
34	263.2	205.6	94	310.5	242.6	54	357.8	279.5	14	405.0	316.4	74	452.3	353.4
35	264.0	206.3	95	311.3	243.2	55	358.5	280.1	15	405.8	317.1	75	453.1	354.0
36	264.8	206.9	96	312.1	243.8	56	359.3	280.7	16	406.6	317.7	76	453.9	354.6
37	265.6	207.5	97	312.8	244.4	57	360.1	281.4	17	407.4	318.3	77	454.7	355.2
38	266.3	208.1	98	313.6	245.0	58	360.9	282.0	18	408.2	318.9	78	455.5	355.8
39	267.1	208.7	99	314.4	245.7	59	361.7	282.6	19	409.0	319.5	79	456.3	356.4
40	267.9	209.3	400	315.2	246.3	60	362.5	283.2	20	409.8	320.2	80	457.1	357.1
341	268.7	209.9	401	316.0	246.9	461	363.3	283.8	521	410.6	320.8	581	457.8	357.7
42	269.5	210.6	02	316.8	247.5	62	364.1	284.4	22	411.3	321.4	82	458.6	358.3
43	270.3	211.2	03	317.6	248.1	63	364.9	285.1	23	412.1	322.0	83	459.4	358.9
44	271.1	211.8	04	318.4	248.7	64	365.6	285.7	24	412.9	322.6	84	460.2	359.5
45	271.9	212.4	05	319.1	249.3	65	366.4	286.3	25	413.7	323.2	85	461.0	360.2
46	272.7	213.0	06	319.9	250.0	66	367.2	286.9	26	414.5	323.8	86	461.8	360.8
47	273.4	213.6	07	320.7	250.6	67	368.0	287.5	27	415.3	324.5	87	462.6	361.4
48	274.2	214.3	08	321.5	251.2	68	368.8	288.1	28	416.1	325.1	88	463.3	362.0
49	275.0	214.9	09	322.3	251.8	69	369.6	288.7	29	416.9	325.7	89	464.1	362.6
50	275.8	215.5	10	323.1	252.4	70	370.4	289.3	30	417.6	326.3	90	464.9	363.2
351	276.6	216.1	411	323.9	253.0	471	371.2	290.0	531	418.4	326.9	591	465.7	363.8
52	277.4	216.7	12	324.7	253.7	72	371.9	290.6	32	419.2	327.5	92	466.5	364.4
53	278.2	217.3	13	325.5	254.3	73	372.7	291.2	33	420.0	328.2	93	467.3	365.1
54	279.0	218.0	14	326.2	254.9	74	373.5	291.8	34	420.8	328.8	94	468.1	365.7
55	279.7	218.6	15	327.0	255.5	75	374.3	292.4	35	421.6	329.4	95	468.9	366.3
56	280.5	219.2	16	327.8	256.1	76	375.1	293.1	36	422.4	330.0	96	469.7	366.9
57	281.3	219.8	17	328.6	256.7	77	375.9	293.7	37	423.2	330.6	97	470.5	367.5
58	282.1	220.4	18	329.4	257.4	78	376.7	294.3	38	424.0	331.2	98	471.2	368.1
59	282.9	221.0	19	330.2	258.0	79	377.5	294.9	39	424.7	331.8	99	472.0	368.7
60	283.7	221.6	20	331.0	258.6	80	378.2	295.5	40	425.5	332.5	600	472.8	369.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

52° (128°, 232°, 308°).

TABLE 2.

Difference of Latitude and Departure for 39° (141°, 219°, 321°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	0.8	0.6	61	47.4	38.4	121	94.0	76.1	181	140.7	113.9	241	187.3	151.7
2	1.6	1.3	62	48.2	39.0	22	94.8	76.8	82	141.4	114.5	42	188.1	152.3
3	2.3	1.9	63	49.0	39.6	23	95.6	77.4	83	142.2	115.2	43	188.8	152.9
4	3.1	2.5	64	49.7	40.3	24	96.4	78.0	84	143.0	115.8	44	189.6	153.6
5	3.9	3.1	65	50.5	40.9	25	97.1	78.7	85	143.8	116.4	45	190.4	154.2
6	4.7	3.8	66	51.3	41.5	26	97.9	79.3	86	144.5	117.1	46	191.2	154.8
7	5.4	4.4	67	52.1	42.2	27	98.7	79.9	87	145.3	117.7	47	192.0	155.4
8	6.2	5.0	68	52.8	42.8	28	99.5	80.6	88	146.1	118.3	48	192.7	156.1
9	7.0	5.7	69	53.6	43.4	29	100.3	81.2	89	146.9	118.9	49	193.5	156.7
10	7.8	6.3	70	54.4	44.1	30	101.0	81.8	90	147.7	119.6	50	194.3	157.3
11	8.5	6.9	71	55.2	44.7	131	101.8	82.4	191	148.4	120.2	251	195.1	158.0
12	9.3	7.6	72	56.0	45.3	32	102.6	83.1	92	149.2	120.8	52	195.8	158.6
13	10.1	8.2	73	56.7	45.9	33	103.4	83.7	93	150.0	121.5	53	196.6	159.2
14	10.9	8.8	74	57.5	46.6	34	104.1	84.3	94	150.8	122.1	54	197.4	159.8
15	11.7	9.4	75	58.3	47.2	35	104.9	85.0	95	151.5	122.7	55	198.2	160.5
16	12.4	10.1	76	59.1	47.8	36	105.7	85.6	96	152.3	123.3	56	198.9	161.1
17	13.2	10.7	77	59.8	48.5	37	106.5	86.2	97	153.1	124.0	57	199.7	161.7
18	14.0	11.3	78	60.6	49.1	38	107.2	86.8	98	153.9	124.6	58	200.5	162.4
19	14.8	12.0	79	61.4	49.7	39	108.0	87.5	99	154.7	125.2	59	201.3	163.0
20	15.5	12.6	80	62.2	50.3	40	108.8	88.1	200	155.4	125.9	60	202.1	163.6
21	16.3	13.2	81	62.9	51.0	141	109.6	88.7	201	156.2	126.5	261	202.8	164.3
22	17.1	13.8	82	63.7	51.6	42	110.4	89.4	02	157.0	127.1	62	203.6	164.9
23	17.9	14.5	83	64.5	52.2	43	111.1	90.0	03	157.8	127.8	63	204.4	165.5
24	18.7	15.1	84	65.3	52.9	44	111.9	90.6	04	158.5	128.4	64	205.2	166.1
25	19.4	15.7	85	66.1	53.5	45	112.7	91.3	05	159.3	129.0	65	205.9	166.8
26	20.2	16.4	86	66.8	54.1	46	113.5	91.9	06	160.1	129.6	66	206.7	167.4
27	21.0	17.0	87	67.6	54.8	47	114.2	92.5	07	160.9	130.3	67	207.5	168.0
28	21.8	17.6	88	68.4	55.4	48	115.0	93.1	08	161.6	130.9	68	208.3	168.7
29	22.5	18.3	89	69.2	56.0	49	115.8	93.8	09	162.4	131.5	69	209.1	169.3
30	23.3	18.9	90	69.9	56.6	50	116.6	94.4	10	163.2	132.2	70	209.8	169.9
31	24.1	19.5	91	70.7	57.3	151	117.3	95.0	211	164.0	132.8	271	210.6	170.5
32	24.9	20.1	92	71.5	57.9	52	118.1	95.7	12	164.8	133.4	72	211.4	171.2
33	25.6	20.8	93	72.3	58.5	53	118.9	96.3	13	165.5	134.0	73	212.2	171.8
34	26.4	21.4	94	73.1	59.2	54	119.7	96.9	14	166.3	134.7	74	212.9	172.4
35	27.2	22.0	95	73.8	59.8	55	120.5	97.5	15	167.1	135.3	75	213.7	173.1
36	28.0	22.7	96	74.6	60.4	56	121.2	98.2	16	167.9	135.9	76	214.5	173.7
37	28.8	23.3	97	75.4	61.0	57	122.0	98.8	17	168.6	136.6	77	215.3	174.3
38	29.5	23.9	98	76.2	61.7	58	122.8	99.4	18	169.4	137.2	78	216.0	175.0
39	30.3	24.5	99	76.9	62.3	59	123.6	100.1	19	170.2	137.8	79	216.8	175.6
40	31.1	25.2	100	77.7	62.9	60	124.3	100.7	20	171.0	138.5	80	217.6	176.2
41	31.9	25.8	101	78.5	63.6	161	125.1	101.3	221	171.7	139.1	281	218.4	176.8
42	32.6	26.4	02	79.3	64.2	62	125.9	101.9	22	172.5	139.7	82	219.2	177.5
43	33.4	27.1	03	80.0	64.8	63	126.7	102.6	23	173.3	140.3	83	219.9	178.1
44	34.2	27.7	04	80.8	65.4	64	127.5	103.2	24	174.1	141.0	84	220.7	178.7
45	35.0	28.3	05	81.6	66.1	65	128.2	103.8	25	174.9	141.6	85	221.5	179.4
46	35.7	28.9	06	82.4	66.7	66	129.0	104.5	26	175.6	142.2	86	222.3	180.0
47	36.5	29.6	07	83.2	67.3	67	129.8	105.1	27	176.4	142.9	87	223.0	180.6
48	37.3	30.2	08	83.9	68.0	68	130.6	105.7	28	177.2	143.5	88	223.8	181.2
49	38.1	30.8	09	84.7	68.6	69	131.3	106.4	29	178.0	144.1	89	224.6	181.9
50	38.9	31.5	10	85.5	69.2	70	132.1	107.0	30	178.7	144.7	90	225.4	182.5
51	39.6	32.1	111	86.3	69.9	171	132.9	107.6	231	179.5	145.4	291	226.1	183.1
52	40.4	32.7	12	87.0	70.5	72	133.7	108.2	32	180.3	146.0	92	226.9	183.8
53	41.2	33.4	13	87.8	71.1	73	134.4	108.9	33	181.1	146.6	93	227.7	184.4
54	42.0	34.0	14	88.6	71.7	74	135.2	109.5	34	181.9	147.3	94	228.5	185.0
55	42.7	34.6	15	89.4	72.4	75	136.0	110.1	35	182.6	147.9	95	229.3	185.6
56	43.5	35.2	16	90.1	73.0	76	136.8	110.8	36	183.4	148.5	96	230.0	186.3
57	44.3	35.9	17	90.9	73.6	77	137.6	111.4	37	184.2	149.1	97	230.8	186.9
58	45.1	36.5	18	91.7	74.3	78	138.3	112.0	38	185.0	149.8	98	231.6	187.5
59	45.9	37.1	19	92.5	74.9	79	139.1	112.6	39	185.7	150.4	99	232.4	188.2
60	46.6	37.8	20	93.3	75.5	80	139.9	113.3	40	186.5	151.0	300	233.1	188.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

51° (129°, 231°, 309°).

TABLE 2.

Difference of Latitude and Departure for 39° (141°, 219°, 321°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	233.9	189.4	361	280.6	227.1	421	327.2	264.9	481	373.8	302.6	541	420.4	340.4
02	234.7	190.0	62	281.3	227.8	22	328.0	265.5	82	374.6	303.3	42	421.2	341.0
03	235.5	190.6	63	282.1	228.4	23	328.7	266.2	83	375.4	303.9	43	422.0	341.7
04	236.3	191.3	64	282.9	229.0	24	329.5	266.8	84	376.1	304.5	44	422.7	342.3
05	237.0	191.9	65	283.7	229.7	25	330.3	267.4	85	376.9	305.2	45	423.5	342.9
06	237.8	192.5	66	284.4	230.3	26	331.1	268.0	86	377.7	305.8	46	424.3	343.6
07	238.6	193.2	67	285.2	230.9	27	331.9	268.7	87	378.5	306.4	47	425.1	344.2
08	239.4	193.8	68	286.0	231.5	28	332.6	269.3	88	379.3	307.1	48	425.9	344.8
09	240.1	194.4	69	286.8	232.2	29	333.4	269.9	89	380.0	307.7	49	426.6	345.5
10	240.9	195.0	70	287.6	232.8	30	334.2	270.6	90	380.8	308.3	50	427.4	346.1
311	241.7	195.7	371	288.3	233.4	431	335.0	271.2	491	381.6	308.9	551	428.2	346.7
12	242.5	196.3	72	289.1	234.1	32	335.7	271.8	92	382.4	309.6	52	429.0	347.4
13	243.3	196.9	73	289.9	234.7	33	336.5	272.5	93	383.1	310.2	53	429.7	348.0
14	244.0	197.6	74	290.7	235.3	34	337.3	273.1	94	383.9	310.8	54	430.5	348.6
15	244.8	198.2	75	291.4	236.0	35	338.1	273.7	95	384.7	311.5	55	431.3	349.2
16	245.6	198.8	76	292.2	236.6	36	338.8	274.3	96	385.5	312.1	56	432.1	349.9
17	246.4	199.5	77	293.0	237.2	37	339.6	275.0	97	386.2	312.7	57	432.8	350.5
18	247.1	200.1	78	293.8	237.8	38	340.4	275.6	98	387.0	313.3	58	433.6	351.1
19	247.9	200.7	79	294.5	238.5	39	341.2	276.2	99	387.8	314.0	59	434.4	351.7
20	248.7	201.3	80	295.3	239.1	40	342.0	276.9	500	388.6	314.7	60	435.2	352.4
321	249.5	202.0	381	296.1	239.7	441	342.7	277.5	501	389.4	315.3	561	435.9	353.0
22	250.3	202.6	82	296.9	240.4	42	343.5	278.1	02	390.1	315.9	62	436.7	353.6
23	251.0	203.2	83	297.7	241.0	43	344.3	278.7	03	390.9	316.5	63	437.5	354.3
24	251.8	203.9	84	298.4	241.6	44	345.1	279.4	04	391.7	317.1	64	438.3	354.9
25	252.6	204.5	85	299.2	242.2	45	345.8	280.0	05	392.5	317.8	65	439.1	355.5
26	253.4	205.1	86	300.0	242.9	46	346.6	280.6	06	393.2	318.4	66	439.8	356.2
27	254.1	205.7	87	300.8	243.5	47	347.4	281.3	07	394.0	319.0	67	440.6	356.8
28	254.9	206.4	88	301.5	244.1	48	348.2	281.9	08	394.8	319.6	68	441.4	357.4
29	255.7	207.0	89	302.3	244.8	49	349.0	282.5	09	395.6	320.3	69	442.2	358.1
30	256.5	207.6	90	303.1	245.4	50	349.7	283.2	10	396.3	320.9	70	443.0	358.7
331	257.2	208.3	391	303.9	246.0	451	350.5	283.8	511	397.1	321.6	571	443.7	359.3
32	258.0	208.9	92	304.7	246.7	52	351.3	284.4	12	397.9	322.2	72	444.5	359.9
33	258.8	209.5	93	305.4	247.3	53	352.1	285.0	13	398.7	322.8	73	445.3	360.6
34	259.6	210.2	94	306.2	247.9	54	352.8	285.7	14	399.4	323.4	74	446.1	361.2
35	260.4	210.8	95	307.0	248.5	55	353.6	286.3	15	400.2	324.1	75	446.9	361.8
36	261.1	211.4	96	307.8	249.2	56	354.4	286.9	16	401.0	324.7	76	447.6	362.4
37	261.9	212.0	97	308.5	249.8	57	355.2	287.6	17	401.8	325.3	77	448.4	363.1
38	262.7	212.7	98	309.3	250.4	58	355.9	288.2	18	402.5	325.9	78	449.2	363.7
39	263.5	213.3	99	310.1	251.1	59	356.7	288.8	19	403.3	326.6	79	450.0	364.3
40	264.2	213.9	400	310.9	251.7	60	357.5	289.4	20	404.1	327.2	80	450.7	365.0
341	265.0	214.6	401	311.6	252.3	461	358.3	290.1	521	404.9	327.8	581	451.5	365.6
42	265.8	215.2	02	312.4	252.9	62	359.1	290.7	22	405.7	328.5	82	452.3	366.2
43	266.6	215.8	03	313.2	253.6	63	359.8	291.3	23	406.4	329.1	83	453.1	366.9
44	267.3	216.4	04	314.0	254.2	64	360.6	292.0	24	407.2	329.7	84	453.9	367.5
45	268.1	217.1	05	314.8	254.8	65	361.4	292.6	25	408.0	330.4	85	454.6	368.1
46	268.9	217.7	06	315.5	255.5	66	362.2	293.2	26	408.8	331.0	86	455.4	368.8
47	269.7	218.3	07	316.3	256.1	67	362.9	293.8	27	409.5	331.6	87	456.2	369.4
48	270.5	219.0	08	317.1	256.7	68	363.7	294.5	28	410.3	332.3	88	457.0	370.0
49	271.2	219.6	09	317.9	257.3	69	364.5	295.1	29	411.1	332.9	89	457.8	370.6
50	272.0	220.2	10	318.6	258.0	70	365.3	295.7	30	411.9	333.5	90	458.5	371.3
351	272.8	220.8	411	319.4	258.6	471	366.0	296.4	531	412.6	334.1	591	459.3	371.9
52	273.6	221.5	12	320.2	259.2	72	366.8	297.0	32	413.4	334.8	92	460.1	372.5
53	274.3	222.1	13	321.0	259.9	73	367.6	297.6	33	414.2	335.4	93	460.9	373.2
54	275.1	222.7	14	321.8	260.5	74	368.4	298.3	34	415.0	336.1	94	461.6	373.8
55	275.9	223.4	15	322.5	261.1	75	369.2	298.9	35	415.8	336.7	95	462.4	374.4
56	276.7	224.0	16	323.3	261.8	76	369.9	299.5	36	416.5	337.3	96	463.2	375.1
57	277.5	224.6	17	324.1	262.4	77	370.7	300.1	37	417.3	337.9	97	464.0	375.7
58	278.2	225.3	18	324.9	263.0	78	371.5	300.8	38	418.1	338.5	98	464.8	376.3
59	279.0	225.9	19	325.6	263.6	79	372.3	301.4	39	418.9	339.1	99	465.5	376.9
60	279.8	226.5	20	326.4	264.3	80	373.0	302.0	40	419.6	339.8	600	466.3	377.6
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

51° (129°, 231°, 309°).

TABLE 2.

Difference of Latitude and Departure for 40° (140°, 220°, 320°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	0.8	0.6	61	46.7	39.2	121	92.7	77.8	181	138.7	116.3	241	184.6	154.9
2	1.5	1.3	62	47.5	39.9	22	93.5	78.4	82	139.4	117.0	42	185.4	155.6
3	2.3	1.9	63	48.3	40.5	23	94.2	79.1	83	140.2	117.6	43	186.1	156.2
4	3.1	2.6	64	49.0	41.1	24	95.0	79.7	84	141.0	118.3	44	186.9	156.8
5	3.8	3.2	65	49.8	41.8	25	95.8	80.3	85	141.7	118.9	45	187.7	157.5
6	4.6	3.9	66	50.6	42.4	26	96.5	81.0	86	142.5	119.6	46	188.4	158.1
7	5.4	4.5	67	51.3	43.1	27	97.3	81.6	87	143.3	120.2	47	189.2	158.8
8	6.1	5.1	68	52.1	43.7	28	98.1	82.3	88	144.0	120.8	48	190.0	159.4
9	6.9	5.8	69	52.9	44.4	29	98.8	82.9	89	144.8	121.5	49	190.7	160.1
10	7.7	6.4	70	53.6	45.0	30	99.6	83.6	90	145.5	122.1	50	191.5	160.7
11	8.4	7.1	71	54.4	45.6	131	100.4	84.2	191	146.3	122.8	251	192.3	161.3
12	9.2	7.7	72	55.2	46.3	32	101.1	84.8	92	147.1	123.4	52	193.0	162.0
13	10.0	8.4	73	55.9	46.9	33	101.9	85.5	93	147.8	124.1	53	193.8	162.6
14	10.7	9.0	74	56.7	47.6	34	102.6	86.1	94	148.6	124.7	54	194.6	163.3
15	11.5	9.6	75	57.5	48.2	35	103.4	86.8	95	149.4	125.3	55	195.3	163.9
16	12.3	10.3	76	58.2	48.9	36	104.2	87.4	96	150.1	126.0	56	196.1	164.6
17	13.0	10.9	77	59.0	49.5	37	104.9	88.1	97	150.9	126.6	57	196.9	165.2
18	13.8	11.6	78	59.8	50.1	38	105.7	88.7	98	151.7	127.3	58	197.6	165.8
19	14.6	12.2	79	60.5	50.8	39	106.5	89.3	99	152.4	127.9	59	198.4	166.5
20	15.3	12.9	80	61.3	51.4	40	107.2	90.0	200	153.2	128.6	60	199.2	167.1
21	16.1	13.5	81	62.0	52.1	141	108.0	90.6	201	154.0	129.2	261	199.9	167.8
22	16.9	14.1	82	62.8	52.7	42	108.8	91.3	02	154.7	129.8	62	200.7	168.4
23	17.6	14.8	83	63.6	53.4	43	109.5	91.9	03	155.5	130.5	63	201.5	169.1
24	18.4	15.4	84	64.3	54.0	44	110.3	92.6	04	156.3	131.1	64	202.2	169.7
25	19.2	16.1	85	65.1	54.6	45	111.1	93.2	05	157.0	131.8	65	203.0	170.3
26	19.9	16.7	86	65.9	55.3	46	111.8	93.8	06	157.8	132.4	66	203.8	171.0
27	20.7	17.4	87	66.6	55.9	47	112.6	94.5	07	158.6	133.1	67	204.5	171.6
28	21.4	18.0	88	67.4	56.6	48	113.4	95.1	08	159.3	133.7	68	205.3	172.3
29	22.2	18.6	89	68.2	57.2	49	114.1	95.8	09	160.1	134.3	69	206.1	172.9
30	23.0	19.3	90	68.9	57.9	50	114.9	96.4	10	160.9	135.0	70	206.8	173.6
31	23.7	19.9	91	69.7	58.5	151	115.7	97.1	211	161.6	135.6	271	207.6	174.2
32	24.5	20.6	92	70.5	59.1	52	116.4	97.7	12	162.4	136.3	72	208.4	174.8
33	25.3	21.2	93	71.2	59.8	53	117.2	98.3	13	163.2	136.9	73	209.1	175.5
34	26.0	21.9	94	72.0	60.4	54	118.0	99.0	14	163.9	137.6	74	209.9	176.1
35	26.8	22.5	95	72.8	61.1	55	118.7	99.6	15	164.7	138.2	75	210.7	176.8
36	27.6	23.1	96	73.5	61.7	56	119.5	100.3	16	165.5	138.8	76	211.4	177.4
37	28.3	23.8	97	74.3	62.4	57	120.3	100.9	17	166.2	139.5	77	212.2	178.1
38	29.1	24.4	98	75.1	63.0	58	121.0	101.6	18	167.0	140.1	78	213.0	178.7
39	29.9	25.1	99	75.8	63.6	59	121.8	102.2	19	167.8	140.8	79	213.7	179.3
40	30.6	25.7	100	76.6	64.3	60	122.6	102.8	20	168.5	141.4	80	214.5	180.0
41	31.4	26.4	101	77.4	64.9	161	123.3	103.5	221	169.3	142.1	281	215.3	180.6
42	32.2	27.0	02	78.1	65.6	62	124.1	104.1	22	170.1	142.7	82	216.0	181.3
43	32.9	27.6	03	78.9	66.2	63	124.9	104.8	23	170.8	143.3	83	216.8	181.9
44	33.7	28.3	04	79.7	66.8	64	125.6	105.4	24	171.6	144.0	84	217.6	182.6
45	34.5	28.9	05	80.4	67.5	65	126.4	106.1	25	172.4	144.6	85	218.3	183.2
46	35.2	29.6	06	81.2	68.1	66	127.2	106.7	26	173.1	145.3	86	219.1	183.8
47	36.0	30.2	07	82.0	68.8	67	127.9	107.3	27	173.9	145.9	87	219.9	184.5
48	36.8	30.9	08	82.7	69.4	68	128.7	108.0	28	174.7	146.6	88	220.6	185.1
49	37.5	31.5	09	83.5	70.1	69	129.5	108.6	29	175.4	147.2	89	221.4	185.8
50	38.3	32.1	10	84.3	70.7	70	130.2	109.3	30	176.2	147.8	90	222.2	186.4
51	39.1	32.8	111	85.0	71.3	171	131.0	109.9	231	177.0	148.5	291	222.9	187.1
52	39.8	33.4	12	85.8	72.0	72	131.8	110.6	32	177.7	149.1	92	223.7	187.7
53	40.6	34.1	13	86.6	72.6	73	132.5	111.2	33	178.5	149.8	93	224.5	188.3
54	41.4	34.7	14	87.3	73.3	74	133.3	111.8	34	179.3	150.4	94	225.2	189.0
55	42.1	35.4	15	88.1	73.9	75	134.1	112.5	35	180.0	151.1	95	226.0	189.6
56	42.9	36.0	16	88.9	74.6	76	134.8	113.1	36	180.8	151.7	96	226.7	190.3
57	43.7	36.6	17	89.6	75.2	77	135.6	113.8	37	181.6	152.3	97	227.5	190.9
58	44.4	37.3	18	90.4	75.8	78	136.4	114.4	38	182.3	153.0	98	228.3	191.6
59	45.2	37.9	19	91.2	76.5	79	137.1	115.1	39	183.1	153.6	99	229.0	192.2
60	46.0	38.6	20	91.9	77.1	80	137.9	115.7	40	183.9	154.3	300	229.8	192.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

50° (130°, 230°, 310°).

TABLE 2.

Difference of Latitude and Departure for 40° (140°, 220°, 320°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	230.6	193.5	361	276.5	232.1	421	322.5	270.6	481	368.5	309.2	541	414.4	347.7
02	231.3	194.1	62	277.3	232.7	22	323.3	271.3	82	369.2	309.8	42	415.2	348.4
03	232.1	194.8	63	278.1	233.3	23	324.0	271.9	83	370.0	310.5	43	416.0	349.0
04	232.9	195.4	64	278.8	234.0	24	324.8	272.6	84	370.8	311.1	44	416.7	349.7
05	233.6	196.1	65	279.6	234.6	25	325.6	273.2	85	371.5	311.7	45	417.5	350.3
06	234.4	196.7	66	280.4	235.3	26	326.3	273.8	86	372.3	312.4	46	418.3	351.0
07	235.2	197.3	67	281.1	235.9	27	327.1	274.5	87	373.1	313.0	47	419.0	351.6
08	235.9	198.0	68	281.9	236.6	28	327.9	275.1	88	373.8	313.6	48	419.8	352.2
09	236.7	198.6	69	282.7	237.2	29	328.6	275.8	89	374.6	314.3	49	420.6	352.9
10	237.5	199.3	70	283.4	237.8	30	329.4	276.4	90	375.4	314.9	50	421.3	353.5
311	238.2	199.9	371	284.2	238.5	431	330.2	277.1	491	376.1	315.6	551	422.1	354.2
12	239.0	200.6	72	285.0	239.1	32	330.9	277.7	92	376.9	316.2	52	422.9	354.8
13	239.8	201.2	73	285.7	239.7	33	331.7	278.3	93	377.7	316.9	53	423.6	355.5
14	240.5	201.8	74	286.5	240.4	34	332.5	279.0	94	378.4	317.5	54	424.4	356.1
15	241.3	202.5	75	287.3	241.0	35	333.2	279.6	95	379.2	318.2	55	425.2	356.8
16	242.1	203.1	76	288.0	241.7	36	334.0	280.3	96	380.0	318.8	56	425.9	357.4
17	242.8	203.8	77	288.8	242.3	37	334.8	280.9	97	380.7	319.5	57	426.7	358.0
18	243.6	204.4	78	289.6	243.0	38	335.5	281.6	98	381.5	320.1	58	427.5	358.7
19	244.4	205.1	79	290.3	243.6	39	336.3	282.2	99	382.3	320.8	59	428.2	359.3
20	245.1	205.7	80	291.1	244.3	40	337.1	282.8	500	383.0	321.4	60	429.0	360.0
321	245.9	206.3	381	291.9	244.9	441	337.8	283.5	501	383.8	322.0	561	429.8	360.6
22	246.7	207.0	82	292.6	245.6	42	338.6	284.1	02	384.6	322.7	62	430.5	361.2
23	247.4	207.6	83	293.4	246.2	43	339.4	284.8	03	385.3	323.3	63	431.3	361.9
24	248.2	208.3	84	294.2	246.8	44	340.1	285.4	04	386.1	324.0	64	432.1	362.5
25	249.0	208.9	85	294.9	247.5	45	340.9	286.0	05	386.8	324.6	65	432.8	363.2
26	249.7	209.6	86	295.7	248.1	46	341.7	286.7	06	387.6	325.2	66	433.6	363.8
27	250.5	210.2	87	296.5	248.8	47	342.4	287.3	07	388.4	325.9	67	434.3	364.5
28	251.3	210.8	88	297.2	249.4	48	343.2	288.0	08	389.2	326.5	68	435.1	365.1
29	252.0	211.5	89	298.0	250.1	49	344.0	288.6	09	389.9	327.1	69	435.9	365.8
30	252.8	212.1	90	298.8	250.7	50	344.7	289.3	10	390.7	327.8	70	436.6	366.4
331	253.6	212.8	391	299.5	251.3	451	345.5	289.9	511	391.5	328.4	571	437.4	367.0
32	254.3	213.4	92	300.3	252.0	52	346.3	290.5	12	392.2	329.1	72	438.2	367.7
33	255.1	214.1	93	301.1	252.6	53	347.0	291.2	13	393.0	329.7	73	438.9	368.3
34	255.9	214.7	94	301.8	253.3	54	347.8	291.8	14	393.8	330.4	74	439.7	369.0
35	256.6	215.3	95	302.6	253.9	55	348.6	292.5	15	394.5	331.0	75	440.5	369.6
36	257.4	216.0	96	303.4	254.6	56	349.3	293.1	16	395.3	331.6	76	441.2	370.2
37	258.2	216.6	97	304.1	255.2	57	350.1	293.8	17	396.1	332.3	77	442.0	370.9
38	258.9	217.3	98	304.9	255.8	58	350.8	294.4	18	396.8	332.9	78	442.8	371.5
39	259.7	217.9	99	305.7	256.5	59	351.6	295.0	19	397.6	333.6	79	443.5	372.2
40	260.5	218.6	400	306.4	257.1	60	352.4	295.7	20	398.3	334.2	80	444.3	372.8
341	261.2	219.2	401	307.2	257.8	461	353.1	296.3	521	399.1	334.9	581	445.1	373.5
42	262.0	219.8	02	308.0	258.4	62	353.9	297.0	22	399.9	335.5	82	445.8	374.1
43	262.8	220.5	03	308.7	259.1	63	354.7	297.6	23	400.6	336.1	83	446.6	374.8
44	263.5	221.1	04	309.5	259.7	64	355.4	298.3	24	401.4	336.8	84	447.4	375.4
45	264.3	221.8	05	310.2	260.3	65	356.2	298.9	25	402.2	337.4	85	448.1	376.0
46	265.1	222.4	06	311.0	261.0	66	357.0	299.5	26	402.9	338.1	86	448.9	376.7
47	265.8	223.1	07	311.8	261.6	67	357.7	300.2	27	403.7	338.7	87	449.7	377.3
48	266.6	223.7	08	312.5	262.3	68	358.5	300.8	28	404.5	339.4	88	450.4	378.0
49	267.4	224.3	09	313.3	262.9	69	359.3	301.5	29	405.2	340.0	89	451.2	378.6
50	268.1	225.0	10	314.1	263.6	70	360.0	302.1	30	406.0	340.6	90	452.0	379.2
351	268.9	225.6	411	314.8	264.2	471	360.8	302.8	531	406.8	341.3	591	452.7	379.9
52	269.6	226.3	12	315.6	264.8	72	361.6	303.4	32	407.5	341.9	92	453.5	380.5
53	270.4	226.9	13	316.4	265.5	73	362.3	304.0	33	408.3	342.6	93	454.3	381.2
54	271.2	227.6	14	317.1	266.1	74	363.1	304.7	34	409.1	343.2	94	455.0	381.8
55	271.9	228.2	15	317.9	266.8	75	363.9	305.3	35	409.8	343.9	95	455.8	382.4
56	272.7	228.8	16	318.7	267.4	76	364.6	306.0	36	410.6	344.5	96	456.6	383.1
57	273.5	229.5	17	319.4	268.1	77	365.4	306.6	37	411.4	345.2	97	457.3	383.7
58	274.2	230.1	18	320.2	268.7	78	366.2	307.3	38	412.1	345.8	98	458.1	384.4
59	275.0	230.8	19	321.0	269.3	79	366.9	307.9	39	412.9	346.4	99	458.9	385.0
60	275.8	231.4	20	321.7	270.0	80	367.7	308.5	40	413.7	347.1	600	459.6	385.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

50° (130°, 230°, 310°).

TABLE 2.

Difference of Latitude and Departure for 41° (139°, 221°, 319°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	0.8	0.7	61	46.0	40.0	121	91.3	79.4	181	136.6	118.7	241	181.9	158.1
2	1.5	1.3	62	46.8	40.7	22	92.1	80.0	82	137.4	119.4	42	182.6	158.8
3	2.3	2.0	63	47.5	41.3	23	92.8	80.7	83	138.1	120.1	43	183.4	159.4
4	3.0	2.6	64	48.3	42.0	24	93.6	81.4	84	138.9	120.7	44	184.1	160.1
5	3.8	3.3	65	49.1	42.6	25	94.3	82.0	85	139.6	121.4	45	184.9	160.7
6	4.5	3.9	66	49.8	43.3	26	95.1	82.7	86	140.4	122.0	46	185.7	161.4
7	5.3	4.6	67	50.6	44.0	27	95.8	83.3	87	141.1	122.7	47	186.4	162.0
8	6.0	5.2	68	51.3	44.6	28	96.6	84.0	88	141.9	123.3	48	187.2	162.7
9	6.8	5.9	69	52.1	45.3	29	97.4	84.6	89	142.6	124.0	49	187.9	163.4
10	7.5	6.6	70	52.8	45.9	30	98.1	85.3	90	143.4	124.7	50	188.7	164.0
11	8.3	7.2	71	53.6	46.6	131	98.9	85.9	191	144.1	125.3	251	189.4	164.7
12	9.1	7.9	72	54.3	47.2	32	99.6	86.6	92	144.9	126.0	52	190.2	165.3
13	9.8	8.5	73	55.1	47.9	33	100.4	87.3	93	145.7	126.6	53	190.9	166.0
14	10.6	9.2	74	55.8	48.5	34	101.1	87.9	94	146.4	127.3	54	191.7	166.6
15	11.3	9.8	75	56.6	49.2	35	101.9	88.6	95	147.2	127.9	55	192.5	167.3
16	12.1	10.5	76	57.4	49.9	36	102.6	89.2	96	147.9	128.6	56	193.2	168.0
17	12.8	11.2	77	58.1	50.5	37	103.4	89.9	97	148.7	129.2	57	194.0	168.6
18	13.6	11.8	78	58.9	51.2	38	104.1	90.5	98	149.4	129.9	58	194.7	169.3
19	14.3	12.5	79	59.6	51.8	39	104.9	91.2	99	150.2	130.6	59	195.5	169.9
20	15.1	13.1	80	60.4	52.5	40	105.7	91.8	200	150.9	131.2	60	196.2	170.6
21	15.8	13.8	81	61.1	53.1	141	106.4	92.5	201	151.7	131.9	261	197.0	171.2
22	16.6	14.4	82	61.9	53.8	42	107.2	93.2	02	152.5	132.5	62	197.7	171.9
23	17.4	15.1	83	62.6	54.5	43	107.9	93.8	03	153.2	133.2	63	198.5	172.5
24	18.1	15.7	84	63.4	55.1	44	108.7	94.5	04	154.0	133.8	64	199.2	173.2
25	18.9	16.4	85	64.2	55.8	45	109.4	95.1	05	154.7	134.5	65	200.0	173.9
26	19.6	17.1	86	64.9	56.4	46	110.2	95.8	06	155.5	135.1	66	200.8	174.5
27	20.4	17.7	87	65.7	57.1	47	110.9	96.4	07	156.2	135.8	67	201.5	175.2
28	21.1	18.4	88	66.4	57.7	48	111.7	97.1	08	157.0	136.5	68	202.3	175.8
29	21.9	19.0	89	67.2	58.4	49	112.5	97.8	09	157.7	137.1	69	203.0	176.5
30	22.6	19.7	90	67.9	59.0	50	113.2	98.4	10	158.5	137.8	70	203.8	177.1
31	23.4	20.3	91	68.7	59.7	151	114.0	99.1	211	159.2	138.4	271	204.5	177.8
32	24.2	21.0	92	69.4	60.4	52	114.7	99.7	12	160.0	139.1	72	205.3	178.4
33	24.9	21.6	93	70.2	61.0	53	115.5	100.4	13	160.8	139.7	73	206.0	179.1
34	25.7	22.3	94	70.9	61.7	54	116.2	101.0	14	161.5	140.4	74	206.8	179.8
35	26.4	23.0	95	71.7	62.3	55	117.0	101.7	15	162.3	141.1	75	207.5	180.4
36	27.2	23.6	96	72.5	63.0	56	117.7	102.3	16	163.0	141.7	76	208.3	181.1
37	27.9	24.3	97	73.2	63.6	57	118.5	103.0	17	163.8	142.4	77	209.1	181.7
38	28.7	24.9	98	74.0	64.3	58	119.2	103.7	18	164.5	143.0	78	209.8	182.4
39	29.4	25.6	99	74.7	64.9	59	120.0	104.3	19	165.3	143.7	79	210.6	183.0
40	30.2	26.2	100	75.5	65.6	60	120.8	105.0	20	166.0	144.3	80	211.3	183.7
41	30.9	26.9	101	76.2	66.3	161	121.5	105.6	221	166.8	145.0	281	212.1	184.4
42	31.7	27.6	02	77.0	66.9	62	122.3	106.3	22	167.5	145.6	82	212.8	185.0
43	32.5	28.2	03	77.7	67.6	63	123.0	106.9	23	168.3	146.3	83	213.6	185.7
44	33.2	28.9	04	78.5	68.2	64	123.8	107.6	24	169.1	147.0	84	214.3	186.3
45	34.0	29.5	05	79.2	68.9	65	124.5	108.2	25	169.8	147.6	85	215.1	187.0
46	34.7	30.2	06	80.0	69.5	66	125.3	108.9	26	170.6	148.3	86	215.8	187.6
47	35.5	30.8	07	80.8	70.2	67	126.0	109.6	27	171.3	148.9	87	216.6	188.3
48	36.2	31.5	08	81.5	70.9	68	126.8	110.2	28	172.1	149.6	88	217.4	188.9
49	37.0	32.1	09	82.3	71.5	69	127.5	110.9	29	172.8	150.2	89	218.1	189.6
50	37.7	32.8	10	83.0	72.2	70	128.3	111.5	30	173.6	150.9	90	218.9	190.3
51	38.5	33.5	111	83.8	72.8	171	129.1	112.2	231	174.3	151.5	291	219.6	190.9
52	39.2	34.1	12	84.5	73.5	72	129.8	112.8	32	175.1	152.2	92	220.4	191.6
53	40.0	34.8	13	85.3	74.1	73	130.6	113.5	33	175.8	152.9	93	221.1	192.2
54	40.8	35.4	14	86.0	74.8	74	131.3	114.2	34	176.6	153.5	94	221.9	192.9
55	41.5	36.1	15	86.8	75.4	75	132.1	114.8	35	177.4	154.2	95	222.6	193.5
56	42.3	36.7	16	87.5	76.1	76	132.8	115.5	36	178.1	154.8	96	223.4	194.2
57	43.0	37.4	17	88.3	76.8	77	133.6	116.1	37	178.9	155.5	97	224.1	194.8
58	43.8	38.1	18	89.1	77.4	78	134.3	116.8	38	179.6	156.1	98	224.9	195.5
59	44.5	38.7	19	89.8	78.1	79	135.1	117.4	39	180.4	156.8	99	225.7	196.2
60	45.3	39.4	20	90.6	78.7	80	135.8	118.1	40	181.1	157.5	300	226.4	196.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

49° (131°, 229°, 311°).

TABLE 2.

Difference of Latitude and Departure for 41° (139°, 221°, 319°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	227.2	197.5	361	272.5	236.9	421	317.7	276.2	481	363.0	315.6	541	408.3	354.9
02	227.9	198.1	62	273.2	237.5	22	318.5	276.9	82	363.8	316.2	42	409.0	355.6
03	228.7	198.8	63	274.0	238.2	23	319.2	277.5	83	364.5	316.9	43	409.8	356.2
04	229.4	199.4	64	274.7	238.8	24	320.0	278.2	84	365.3	317.5	44	410.6	356.9
05	230.2	200.1	65	275.5	239.5	25	320.8	278.8	85	366.0	318.2	45	411.3	357.5
06	230.9	200.8	66	276.2	240.1	26	321.5	279.5	86	366.8	318.8	46	412.1	358.2
07	231.7	201.4	67	277.0	240.8	27	322.3	280.1	87	367.5	319.5	47	412.8	358.8
08	232.5	202.1	68	277.7	241.4	28	323.0	280.8	88	368.3	320.1	48	413.6	359.5
09	233.2	202.7	69	278.5	242.1	29	323.8	281.5	89	369.0	320.8	49	414.3	360.2
10	234.0	203.4	70	279.2	242.7	30	324.5	282.1	90	369.8	321.5	50	415.1	360.8
311	234.7	204.0	371	280.0	243.4	431	325.3	282.8	491	370.6	322.1	551	415.8	361.5
12	235.5	204.7	72	280.8	244.1	32	326.0	283.4	92	371.3	322.8	52	416.6	362.1
13	236.2	205.4	73	281.5	244.7	33	326.8	284.1	93	372.1	323.4	53	417.3	362.8
14	237.0	206.0	74	282.3	245.4	34	327.5	284.7	94	372.8	324.1	54	418.1	363.4
15	237.7	206.7	75	283.0	246.0	35	328.3	285.4	95	373.6	324.7	55	418.9	364.1
16	238.5	207.3	76	283.8	246.7	36	329.1	286.0	96	374.3	325.4	56	419.6	364.8
17	239.2	208.0	77	284.5	247.3	37	329.8	286.7	97	375.1	326.0	57	420.4	365.4
18	240.0	208.6	78	285.3	248.0	38	330.6	287.4	98	375.8	326.7	58	421.1	366.1
19	240.8	209.3	79	286.0	248.7	39	331.3	288.0	99	376.6	327.4	59	421.9	366.7
20	241.5	209.9	80	286.8	249.3	40	332.1	288.7	500	377.3	328.0	60	422.6	367.4
321	242.3	210.6	381	287.5	250.0	441	332.8	289.3	501	378.1	328.7	561	423.4	368.0
22	243.0	211.3	82	288.3	250.6	42	333.6	290.0	02	378.9	329.3	62	424.1	368.7
23	243.8	211.9	83	289.1	251.3	43	334.3	290.6	03	379.6	330.0	63	424.9	369.4
24	244.5	212.6	84	289.8	251.9	44	335.1	291.3	04	380.4	330.6	64	425.7	370.0
25	245.3	213.2	85	290.6	252.6	45	335.8	292.0	05	381.1	331.3	65	426.4	370.7
26	246.0	213.9	86	291.3	253.2	46	336.6	292.6	06	381.9	332.0	66	427.2	371.3
27	246.8	214.5	87	292.1	253.9	47	337.4	293.3	07	382.6	332.6	67	427.9	372.0
28	247.5	215.2	88	292.8	254.6	48	338.1	293.9	08	383.4	333.3	68	428.7	372.6
29	248.3	215.9	89	293.6	255.2	49	338.9	294.6	09	384.1	333.9	69	429.4	373.3
30	249.1	216.5	90	294.3	255.9	50	339.6	295.2	10	384.9	334.6	70	430.2	374.0
331	249.8	217.2	391	295.1	256.5	451	340.4	295.9	511	385.7	335.2	571	430.9	374.6
32	250.6	217.8	92	295.8	257.2	52	341.1	296.5	12	386.4	335.9	72	431.7	375.3
33	251.3	218.5	93	296.6	257.8	53	341.9	297.2	13	387.2	336.5	73	432.4	375.9
34	252.1	219.1	94	297.4	258.5	54	342.6	297.9	14	387.9	337.2	74	433.2	376.6
35	252.8	219.8	95	298.1	259.2	55	343.4	298.5	15	388.7	337.9	75	434.0	377.2
36	253.6	220.4	96	298.9	259.8	56	344.1	299.2	16	389.4	338.5	76	434.7	377.9
37	254.3	221.1	97	299.6	260.5	57	344.9	299.8	17	390.2	339.2	77	435.5	378.5
38	255.1	221.8	98	300.4	261.1	58	345.7	300.5	18	390.9	339.8	78	436.2	379.2
39	255.8	222.4	99	301.1	261.8	59	346.4	301.1	19	391.7	340.5	79	437.0	379.8
40	256.6	223.1	400	301.9	262.4	60	347.2	301.8	20	392.4	341.1	80	437.7	380.5
341	257.4	223.7	401	302.6	263.1	461	347.9	302.5	521	393.2	341.8	581	438.5	381.2
42	258.1	224.4	02	303.4	263.7	62	348.7	303.1	22	394.0	342.5	82	439.2	381.8
43	258.9	225.0	03	304.2	264.4	63	349.4	303.8	23	394.7	343.1	83	440.0	382.5
44	259.6	225.7	04	304.9	265.1	64	350.2	304.4	24	395.5	343.8	84	440.7	383.2
45	260.4	226.3	05	305.7	265.7	65	350.9	305.1	25	396.2	344.4	85	441.5	383.8
46	261.1	227.0	06	306.4	266.4	66	351.7	305.7	26	397.0	345.1	86	442.3	384.5
47	261.9	227.7	07	307.2	267.0	67	352.5	306.4	27	397.7	345.7	87	443.0	385.1
48	262.6	228.3	08	307.9	267.7	68	353.2	307.0	28	398.5	346.4	88	443.8	385.8
49	263.4	229.0	09	308.7	268.3	69	354.0	307.7	29	399.2	347.0	89	444.5	386.4
50	264.2	229.6	10	309.4	269.0	70	354.7	308.4	30	400.0	347.7	90	445.3	387.1
351	264.9	230.3	411	310.2	269.6	471	355.5	309.0	531	400.7	348.4	591	446.0	387.7
52	265.7	230.9	12	310.9	270.3	72	356.2	309.7	32	401.5	349.0	92	446.8	388.4
53	266.4	231.6	13	311.7	271.0	73	357.0	310.3	33	402.2	349.7	93	447.5	389.1
54	267.2	232.3	14	312.5	271.6	74	357.7	311.0	34	403.0	350.3	94	448.3	389.7
55	267.9	232.9	15	313.2	272.3	75	358.5	311.6	35	403.8	351.0	95	449.1	390.4
56	268.7	233.6	16	314.0	272.9	76	359.2	312.3	36	404.5	351.6	96	449.8	391.0
57	269.4	234.2	17	314.7	273.6	77	360.0	312.9	37	405.3	352.3	97	450.6	391.7
58	270.2	234.9	18	315.5	274.2	78	360.8	313.6	38	406.0	352.9	98	451.3	392.3
59	270.9	235.5	19	316.2	274.9	79	361.5	314.3	39	406.8	353.6	99	452.1	393.0
60	271.7	236.2	20	317.0	275.6	80	362.3	314.9	40	407.5	354.3	600	452.8	393.6
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

49° (131°, 229°, 311°).

TABLE 2.

Difference of Latitude and Departure for 42° (138°, 222°, 318°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	0.7	0.7	61	45.3	40.8	121	89.9	81.0	181	134.5	121.1	241	179.1	161.3
2	1.5	1.3	62	46.1	41.5	22	90.7	81.6	82	135.3	121.8	42	179.8	161.9
3	2.2	2.0	63	46.8	42.2	23	91.4	82.3	83	136.0	122.5	43	180.6	162.6
4	3.0	2.7	64	47.6	42.8	24	92.1	83.0	84	136.7	123.1	44	181.3	163.3
5	3.7	3.3	65	48.3	43.5	25	92.9	83.6	85	137.5	123.8	45	182.1	163.9
6	4.5	4.0	66	49.0	44.2	26	93.6	84.3	86	138.2	124.5	46	182.8	164.6
7	5.2	4.7	67	49.8	44.8	27	94.4	85.0	87	139.0	125.1	47	183.6	165.3
8	5.9	5.4	68	50.5	45.5	28	95.1	85.6	88	139.7	125.8	48	184.3	165.9
9	6.7	6.0	69	51.3	46.2	29	95.9	86.3	89	140.5	126.5	49	185.0	166.6
10	7.4	6.7	70	52.0	46.8	30	96.6	87.0	90	141.2	127.1	50	185.8	167.3
11	8.2	7.4	71	52.8	47.5	131	97.4	87.7	191	141.9	127.8	251	186.5	168.0
12	8.9	8.0	72	53.5	48.2	32	98.1	88.3	92	142.7	128.5	52	187.3	168.6
13	9.7	8.7	73	54.2	48.8	33	98.8	89.0	93	143.4	129.1	53	188.0	169.3
14	10.4	9.4	74	55.0	49.5	34	99.6	89.7	94	144.2	129.8	54	188.8	170.0
15	11.1	10.0	75	55.7	50.2	35	100.3	90.3	95	144.9	130.5	55	189.5	170.6
16	11.9	10.7	76	56.5	50.9	36	101.1	91.0	96	145.7	131.1	56	190.2	171.3
17	12.6	11.4	77	57.2	51.5	37	101.8	91.7	97	146.4	131.8	57	191.0	172.0
18	13.4	12.0	78	58.0	52.2	38	102.6	92.3	98	147.1	132.5	58	191.7	172.6
19	14.1	12.7	79	58.7	52.9	39	103.3	93.0	99	147.9	133.2	59	192.5	173.3
20	14.9	13.4	80	59.5	53.5	40	104.0	93.7	200	148.6	133.8	60	193.2	174.0
21	15.6	14.1	81	60.2	54.2	141	104.8	94.3	201	149.4	134.5	261	194.0	174.6
22	16.3	14.7	82	60.9	54.9	42	105.5	95.0	02	150.1	135.2	62	194.7	175.3
23	17.1	15.4	83	61.7	55.5	43	106.3	95.7	03	150.9	135.8	63	195.4	176.0
24	17.8	16.1	84	62.4	56.2	44	107.0	96.4	04	151.6	136.5	64	196.2	176.7
25	18.6	16.7	85	63.2	56.9	45	107.8	97.0	05	152.3	137.2	65	196.9	177.3
26	19.3	17.4	86	63.9	57.5	46	108.5	97.7	06	153.1	137.8	66	197.7	178.0
27	20.1	18.1	87	64.7	58.2	47	109.2	98.4	07	153.8	138.5	67	198.4	178.7
28	20.8	18.7	88	65.4	58.9	48	110.0	99.0	08	154.6	139.2	68	199.2	179.3
29	21.6	19.4	89	66.1	59.6	49	110.7	99.7	09	155.3	139.8	69	199.9	180.0
30	22.3	20.1	90	66.9	60.2	50	111.5	100.4	10	156.1	140.5	70	200.6	180.7
31	23.0	20.7	91	67.6	60.9	151	112.2	101.0	211	156.8	141.2	271	201.4	181.3
32	23.8	21.4	92	68.4	61.6	52	113.0	101.7	12	157.5	141.9	72	202.1	182.0
33	24.5	22.1	93	69.1	62.2	53	113.7	102.4	13	158.3	142.5	73	202.9	182.7
34	25.3	22.8	94	69.9	62.9	54	114.4	103.0	14	159.0	143.2	74	203.6	183.3
35	26.0	23.4	95	70.6	63.6	55	115.2	103.7	15	159.8	143.9	75	204.4	184.0
36	26.8	24.1	96	71.3	64.2	56	115.9	104.4	16	160.5	144.5	76	205.1	184.7
37	27.5	24.8	97	72.1	64.9	57	116.7	105.1	17	161.3	145.2	77	205.9	185.3
38	28.2	25.4	98	72.8	65.6	58	117.4	105.7	18	162.0	145.9	78	206.6	186.0
39	29.0	26.1	99	73.6	66.2	59	118.2	106.4	19	162.7	146.5	79	207.3	186.7
40	29.7	26.8	100	74.3	66.9	60	118.9	107.1	20	163.5	147.2	80	208.1	187.4
41	30.5	27.4	101	75.1	67.6	161	119.6	107.7	221	164.2	147.9	281	208.8	188.0
42	31.2	28.1	02	75.8	68.3	62	120.4	108.4	22	165.0	148.5	82	209.6	188.7
43	32.0	28.8	03	76.5	68.9	63	121.1	109.1	23	165.7	149.2	83	210.3	189.4
44	32.7	29.4	04	77.3	69.6	64	121.9	109.7	24	166.5	149.9	84	211.1	190.0
45	33.4	30.1	05	78.0	70.3	65	122.6	110.4	25	167.2	150.6	85	211.8	190.7
46	34.2	30.8	06	78.8	70.9	66	123.4	111.1	26	168.0	151.2	86	212.5	191.4
47	34.9	31.4	07	79.5	71.6	67	124.1	111.7	27	168.7	151.9	87	213.3	192.0
48	35.7	32.1	08	80.3	72.3	68	124.8	112.4	28	169.4	152.6	88	214.0	192.7
49	36.4	32.8	09	81.0	72.9	69	125.6	113.1	29	170.2	153.2	89	214.8	193.4
50	37.2	33.5	10	81.7	73.6	70	126.3	113.8	30	170.9	153.9	90	215.5	194.0
51	37.9	34.1	111	82.5	74.3	171	127.1	114.4	231	171.7	154.6	291	216.3	194.7
52	38.6	34.8	12	83.2	74.9	72	127.8	115.1	32	172.4	155.2	92	217.0	195.4
53	39.4	35.5	13	84.0	75.6	73	128.6	115.8	33	173.2	155.9	93	217.7	196.1
54	40.1	36.1	14	84.7	76.3	74	129.3	116.4	34	173.9	156.6	94	218.5	196.7
55	40.9	36.8	15	85.5	77.0	75	130.1	117.1	35	174.6	157.2	95	219.2	197.4
56	41.6	37.5	16	86.2	77.6	76	130.8	117.8	36	175.4	157.9	96	220.0	198.1
57	42.4	38.1	17	86.9	78.3	77	131.5	118.4	37	176.1	158.6	97	220.7	198.7
58	43.1	38.8	18	87.7	79.0	78	132.3	119.1	38	176.9	159.3	98	221.5	199.4
59	43.8	39.5	19	88.4	79.6	79	133.0	119.8	39	177.6	159.9	99	222.2	200.1
60	44.6	40.1	20	89.2	80.3	80	133.8	120.4	40	178.4	160.6	300	222.9	200.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

48° (132°, 228°, 312).

TABLE 2.

Difference of Latitude and Departure for 42° (138°, 222°, 318°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	223.7	201.4	361	268.3	241.6	421	312.9	281.7	481	357.5	321.9	541	402.1	362.0
02	224.4	202.1	62	269.0	242.2	22	313.6	282.4	82	358.2	322.5	42	402.8	362.7
03	225.2	202.8	63	269.8	242.9	23	314.4	283.0	83	358.9	323.2	43	403.5	363.3
04	225.9	203.4	64	270.5	243.6	24	315.1	283.7	84	359.7	323.9	44	404.3	364.0
05	226.6	204.1	65	271.2	244.2	25	315.8	284.4	85	360.4	324.6	45	405.0	364.7
06	227.4	204.8	66	272.0	244.9	26	316.6	285.1	86	361.2	325.2	46	405.8	365.4
07	228.1	205.4	67	272.7	245.6	27	317.3	285.7	87	361.9	325.9	47	406.5	366.0
08	228.9	206.1	68	273.5	246.2	28	318.1	286.4	88	362.7	326.6	48	407.2	366.7
09	229.6	206.8	69	274.2	246.9	29	318.8	287.1	89	363.4	327.2	49	408.0	367.4
10	230.4	207.4	70	275.0	247.6	30	319.6	287.7	90	364.1	327.9	50	408.7	368.0
311	231.1	208.1	371	275.7	248.3	431	320.3	288.4	491	364.9	328.6	551	409.5	368.7
12	231.9	208.8	72	276.5	248.9	32	321.0	289.1	92	365.6	329.2	52	410.2	369.4
13	232.6	209.4	73	277.2	249.6	33	321.8	289.7	93	366.4	329.9	53	411.0	370.0
14	233.3	210.1	74	277.9	250.3	34	322.5	290.4	94	367.1	330.6	54	411.7	370.7
15	234.1	210.8	75	278.7	250.9	35	323.3	291.1	95	367.9	331.3	55	412.4	371.4
16	234.8	211.5	76	279.4	251.6	36	324.0	291.7	96	368.6	331.9	56	413.2	372.0
17	235.6	212.1	77	280.2	252.3	37	324.8	292.4	97	369.3	332.6	57	413.9	372.7
18	236.3	212.8	78	280.9	252.9	38	325.5	293.1	98	370.1	333.3	58	414.7	373.4
19	237.1	213.5	79	281.7	253.6	39	326.2	293.8	99	370.8	333.9	59	415.4	374.1
20	237.8	214.1	80	282.4	254.3	40	327.0	294.4	500	371.6	334.6	60	416.2	374.7
321	238.6	214.8	381	283.1	254.9	441	327.7	295.1	501	372.3	335.3	561	416.9	375.4
22	239.3	215.5	82	283.9	255.6	42	328.5	295.8	02	373.1	335.9	62	417.6	376.1
23	240.0	216.1	83	284.6	256.3	43	329.2	296.4	03	373.8	336.6	63	418.4	376.7
24	240.8	216.8	84	285.4	257.0	44	330.0	297.1	04	374.5	337.2	64	419.1	377.4
25	241.5	217.5	85	286.1	257.6	45	330.7	297.8	05	375.3	337.9	65	419.9	378.1
26	242.3	218.1	86	286.9	258.3	46	331.4	298.4	06	376.0	338.6	66	420.6	378.7
27	243.0	218.8	87	287.6	259.0	47	332.2	299.1	07	376.8	339.3	67	421.4	379.4
28	243.8	219.5	88	288.3	259.6	48	332.9	299.8	08	377.5	339.9	68	422.1	380.1
29	244.5	220.1	89	289.1	260.3	49	333.7	300.4	09	378.3	340.6	69	422.8	380.7
30	245.2	220.8	90	289.8	261.0	50	334.4	301.1	10	379.0	341.3	70	423.6	381.4
331	246.0	221.5	391	290.6	261.6	451	335.2	301.8	511	379.7	341.9	571	424.3	382.1
32	246.7	222.2	92	291.3	262.3	52	335.9	302.5	12	380.5	342.6	72	425.1	382.8
33	247.5	222.8	93	292.1	263.0	53	336.6	303.1	13	381.2	343.3	73	425.8	383.4
34	248.2	223.5	94	292.8	263.6	54	337.4	303.8	14	382.0	343.9	74	426.6	384.1
35	249.0	224.2	95	293.5	264.3	55	338.1	304.5	15	382.7	344.6	75	427.3	384.8
36	249.7	224.8	96	294.3	265.0	56	338.9	305.1	16	383.5	345.3	76	428.0	385.4
37	250.4	225.5	97	295.0	265.7	57	339.6	305.8	17	384.2	346.0	77	428.8	386.1
38	251.2	226.2	98	295.8	266.3	58	340.4	306.5	18	384.9	346.6	78	429.5	386.8
39	251.9	226.8	99	296.5	267.0	59	341.1	307.1	19	385.7	347.3	79	430.3	387.4
40	252.7	227.5	400	297.3	267.7	60	341.8	307.8	20	386.4	348.0	80	431.0	388.1
341	253.4	228.2	401	298.0	268.3	461	342.6	308.5	521	387.2	348.6	581	431.8	388.8
42	254.2	228.8	02	298.7	269.0	62	343.3	309.1	22	387.9	349.3	82	432.5	389.4
43	254.9	229.5	03	299.5	269.7	63	344.1	309.8	23	388.7	350.0	83	433.2	390.1
44	255.6	230.2	04	300.2	270.3	64	344.8	310.5	24	389.4	350.6	84	434.0	390.8
45	256.4	230.9	05	301.0	271.0	65	345.6	311.2	25	390.1	351.3	85	434.7	391.4
46	257.1	231.5	06	301.7	271.7	66	346.3	311.8	26	390.9	352.0	86	435.5	392.1
47	257.9	232.2	07	302.5	272.3	67	347.0	312.5	27	391.6	352.6	87	436.2	392.8
48	258.6	232.9	08	303.2	273.0	68	347.8	313.2	28	392.4	353.3	88	437.0	393.4
49	259.4	233.5	09	303.9	273.7	69	348.5	313.8	29	393.1	354.0	89	437.7	394.1
50	260.1	234.2	10	304.7	274.3	70	349.3	314.5	30	393.9	354.6	90	438.4	394.8
351	260.8	234.9	411	305.4	275.0	471	350.0	315.2	531	394.6	355.3	591	439.2	395.4
52	261.6	235.5	12	306.2	275.7	72	350.8	315.8	32	395.3	356.0	92	440.0	396.1
53	262.3	236.2	13	306.9	276.4	73	351.5	316.5	33	396.1	356.6	93	440.7	396.8
54	263.1	236.9	14	307.7	277.0	74	352.3	317.2	34	396.8	357.3	94	441.4	397.5
55	263.8	237.5	15	308.4	277.7	75	353.0	317.8	35	397.6	358.0	95	442.2	398.1
56	264.6	238.2	16	309.1	278.4	76	353.7	318.5	36	398.3	358.6	96	442.9	398.8
57	265.3	238.9	17	309.9	279.0	77	354.5	319.2	37	399.1	359.3	97	443.7	399.5
58	266.0	239.6	18	310.6	279.7	78	355.2	319.9	38	399.8	360.0	98	444.4	400.1
59	266.8	240.2	19	311.4	280.4	79	356.0	320.5	39	400.6	360.6	99	445.2	400.8
60	267.5	240.9	20	312.1	281.0	80	356.7	321.2	40	401.3	361.3	600	445.9	401.5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

48° (132°, 228°, 312°).

TABLE 2.

Difference of Latitude and Departure for 43° (137°, 223°, 317°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	0.7	0.7	61	44.6	41.6	121	88.5	82.5	181	132.4	123.4	241	176.3	164.4
2	1.5	1.4	62	45.3	42.3	22	89.2	83.2	82	133.1	124.1	42	177.0	165.0
3	2.2	2.0	63	46.1	43.0	23	90.0	83.9	83	133.8	124.8	43	177.7	165.7
4	2.9	2.7	64	46.8	43.6	24	90.7	84.6	84	134.6	125.5	44	178.5	166.4
5	3.7	3.4	65	47.5	44.3	25	91.4	85.2	85	135.3	126.2	45	179.2	167.1
6	4.4	4.1	66	48.3	45.0	26	92.2	85.9	86	136.0	126.9	46	179.9	167.8
7	5.1	4.8	67	49.0	45.7	27	92.9	86.6	87	136.8	127.5	47	180.6	168.5
8	5.9	5.5	68	49.7	46.4	28	93.6	87.3	88	137.5	128.2	48	181.4	169.1
9	6.6	6.1	69	50.5	47.1	29	94.3	88.0	89	138.2	128.9	49	182.1	169.8
10	7.3	6.8	70	51.2	47.7	30	95.1	88.7	90	139.0	129.6	50	182.8	170.5
11	8.0	7.5	71	51.9	48.4	131	95.8	89.3	191	139.7	130.3	251	183.6	171.2
12	8.8	8.2	72	52.7	49.1	32	96.5	90.0	92	140.4	130.9	52	184.3	171.9
13	9.5	8.9	73	53.4	49.8	33	97.3	90.7	93	141.2	131.6	53	185.0	172.5
14	10.2	9.5	74	54.1	50.5	34	98.0	91.4	94	141.9	132.3	54	185.8	173.2
15	11.0	10.2	75	54.9	51.1	35	98.7	92.1	95	142.6	133.0	55	186.5	173.9
16	11.7	10.9	76	55.6	51.8	36	99.5	92.8	96	143.3	133.7	56	187.2	174.6
17	12.4	11.6	77	56.3	52.5	37	100.2	93.4	97	144.1	134.4	57	188.0	175.3
18	13.2	12.3	78	57.0	53.2	38	100.9	94.1	98	144.8	135.0	58	188.7	176.0
19	13.9	13.0	79	57.8	53.9	39	101.7	94.8	99	145.5	135.7	59	189.4	176.6
20	14.6	13.6	80	58.5	54.6	40	102.4	95.5	200	146.3	136.4	60	190.2	177.3
21	15.4	14.3	81	59.2	55.2	141	103.1	96.2	201	147.0	137.1	261	190.9	178.0
22	16.1	15.0	82	60.0	55.9	42	103.9	96.8	02	147.7	137.8	62	191.6	178.7
23	16.8	15.7	83	60.7	56.6	43	104.6	97.5	03	148.5	138.4	63	192.3	179.4
24	17.6	16.4	84	61.4	57.3	44	105.3	98.2	04	149.2	139.1	64	193.1	180.0
25	18.3	17.0	85	62.2	58.0	45	106.0	98.9	05	149.9	139.8	65	193.8	180.7
26	19.0	17.7	86	62.9	58.7	46	106.8	99.6	06	150.7	140.5	66	194.5	181.4
27	19.7	18.4	87	63.6	59.3	47	107.5	100.3	07	151.4	141.2	67	195.3	182.1
28	20.5	19.1	88	64.4	60.0	48	108.2	100.9	08	152.1	141.9	68	196.0	182.8
29	21.2	19.8	89	65.1	60.7	49	109.0	101.6	09	152.9	142.5	69	196.7	183.5
30	21.9	20.5	90	65.8	61.4	50	109.7	102.3	10	153.6	143.2	70	197.5	184.1
31	22.7	21.1	91	66.6	62.1	151	110.4	103.0	211	154.3	143.9	271	198.2	184.8
32	23.4	21.8	92	67.3	62.7	52	111.2	103.7	12	155.0	144.6	72	198.9	185.5
33	24.1	22.5	93	68.0	63.4	53	111.9	104.3	13	155.8	145.3	73	199.7	186.2
34	24.9	23.2	94	68.7	64.1	54	112.6	105.0	14	156.5	145.9	74	200.4	186.9
35	25.6	23.9	95	69.5	64.8	55	113.4	105.7	15	157.2	146.6	75	201.1	187.5
36	26.3	24.6	96	70.2	65.5	56	114.1	106.4	16	158.0	147.3	76	201.9	188.2
37	27.1	25.2	97	70.9	66.2	57	114.8	107.1	17	158.7	148.0	77	202.6	188.9
38	27.8	25.9	98	71.7	66.8	58	115.6	107.8	18	159.4	148.7	78	203.3	189.6
39	28.5	26.6	99	72.4	67.5	59	116.3	108.4	19	160.2	149.4	79	204.0	190.3
40	29.3	27.3	100	73.1	68.2	60	117.0	109.1	20	160.9	150.0	80	204.8	191.0
41	30.0	28.0	101	73.9	68.9	161	117.7	109.8	221	161.6	150.7	281	205.5	191.6
42	30.7	28.6	02	74.6	69.6	62	118.5	110.5	22	162.4	151.4	82	206.2	192.3
43	31.4	29.3	03	75.3	70.2	63	119.2	111.2	23	163.1	152.1	83	207.0	193.0
44	32.2	30.0	04	76.1	70.9	64	119.9	111.8	24	163.8	152.8	84	207.7	193.7
45	32.9	30.7	05	76.8	71.6	65	120.7	112.5	25	164.6	153.4	85	208.4	194.4
46	33.6	31.4	06	77.5	72.3	66	121.4	113.2	26	165.3	154.1	86	209.2	195.1
47	34.4	32.1	07	78.3	73.0	67	122.1	113.9	27	166.0	154.8	87	209.9	195.7
48	35.1	32.7	08	79.0	73.7	68	122.9	114.6	28	166.7	155.5	88	210.6	196.4
49	35.8	33.4	09	79.7	74.3	69	123.6	115.3	29	167.5	156.2	89	211.4	197.1
50	36.6	34.1	10	80.4	75.0	70	124.3	115.9	30	168.2	156.9	90	212.1	197.8
51	37.3	34.8	111	81.2	75.7	171	125.1	116.6	231	168.9	157.5	291	212.8	198.5
52	38.0	35.5	12	81.9	76.4	72	125.8	117.3	32	169.7	158.2	92	213.6	199.1
53	38.8	36.1	13	82.6	77.1	73	126.5	118.0	33	170.4	158.9	93	214.3	199.8
54	39.5	36.8	14	83.4	77.7	74	127.3	118.7	34	171.1	159.6	94	215.0	200.5
55	40.2	37.5	15	84.1	78.4	75	128.0	119.3	35	171.9	160.3	95	215.7	201.2
56	41.0	38.2	16	84.8	79.1	76	128.7	120.0	36	172.6	161.0	96	216.5	201.9
57	41.7	38.9	17	85.6	79.8	77	129.4	120.7	37	173.3	161.6	97	217.2	202.6
58	42.4	39.6	18	86.3	80.5	78	130.2	121.4	38	174.1	162.3	98	217.9	203.2
59	43.1	40.2	19	87.0	81.2	79	130.9	122.1	39	174.8	163.0	99	218.7	203.9
60	43.9	40.9	20	87.8	81.8	80	131.6	122.8	40	175.5	163.7	300	219.4	204.6
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

47° (133°, 227°, 313°).

TABLE 2.

Difference of Latitude and Departure for 43° (137°, 223°, 317°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	220.1	205.3	361	264.0	246.2	421	307.9	287.1	481	351.8	328.1	541	395.7	369.0
02	220 9	206.0	62	264.8	246.9	22	308.6	287.8	82	352.5	328.7	42	396.4	369.7
03	221.6	206.7	63	265.5	247.6	23	309.4	288.5	83	353.2	329.4	43	397.1	370.3
04	222.3	207.3	64	266.2	248.3	24	310.1	289.2	84	354.0	330.1	44	397.9	371.0
05	223.1	208.0	65	267.0	248.9	25	310.8	289.9	85	354.7	330.8	45	398.6	371.7
06	223.8	208.7	66	267.7	249.6	26	311.6	290.5	86	355.4	331.4	46	399.3	372.4
07	224.5	209.4	67	268.4	250.3	27	312.3	291.2	87	356.2	332.1	47	400.1	373.1
08	225.3	210.1	68	269.1	251.0	28	313.0	291.9	88	356.9	332.8	48	400.8	373.7
09	226.0	210.7	69	269.9	251.7	29	313.8	292.6	89	357.7	333.5	49	401.5	374.4
10	226.7	211.4	70	270.6	252.3	30	314.5	293.3	90	358.4	334.2	50	402.2	375.1
311	227.5	212.1	371	271.3	253.0	431	315.2	293.9	491	359.1	334.9	551	403.0	375.8
12	228.2	212.8	72	272.1	253.7	32	316.0	294.6	92	359.8	335.5	52	403.7	376.5
13	228.9	213.5	73	272.8	254.4	33	316.7	295.3	93	360.6	336.2	53	404.4	377.1
14	229.7	214.2	74	273.5	255.1	34	317.4	296.0	94	361.3	336.9	54	405.2	377.8
15	230.4	214.8	75	274.3	255.8	35	318.1	296.7	95	362.0	337.6	55	405.9	378.5
16	231.1	215.5	76	275.0	256.4	36	318.9	297.4	96	362.8	338.3	56	406.6	379.2
17	231.8	216.2	77	275.7	257.1	37	319.6	298.0	97	363.5	338.9	57	407.4	379.9
18	232.6	216.9	78	276.5	257.8	38	320.3	298.7	98	364.2	339.6	58	408.1	380.6
19	233.3	217.6	79	277.2	258.5	39	321.1	299.4	99	364.9	340.3	59	408.8	381.2
20	234.0	218.2	80	277.9	259.2	40	321.8	300.1	500	365.7	341.0	60	409.6	381.9
321	234.8	218.9	381	278.7	259.8	441	322.5	300.8	501	366.4	341.7	561	410.3	382.6
22	235.5	219.6	82	279.4	260.5	42	323.3	301.4	02	367.1	342.4	62	411.0	383.3
23	236.2	220.3	83	280.1	261.2	43	324.0	302.1	03	367.8	343.0	63	411.8	384.0
24	237.0	221.0	84	280.8	261.9	44	324.7	302.8	04	368.6	343.7	64	412.5	384.6
25	237.7	221.7	85	281.6	262.6	45	325.5	303.5	05	369.3	344.4	65	413.2	385.3
26	238.4	222.3	86	282.3	263.3	46	326.2	304.2	06	370.0	345.1	66	414.0	386.0
27	239.2	223.0	87	283.0	263.9	47	326.9	304.9	07	370.8	345.8	67	414.7	386.7
28	239.9	223.7	88	283.7	264.6	48	327.7	305.5	08	371.5	346.5	68	415.4	387.4
29	240.6	224.4	89	284.5	265.3	49	328.4	306.2	09	372.3	347.1	69	416.2	388.1
30	241.4	225.1	90	285.2	266.0	50	329.1	306.9	10	373.0	347.8	70	416.9	388.7
331	242.1	225.7	391	286.0	266.7	451	329.9	307.6	511	373.8	348.5	571	417.6	389.4
32	242.8	226.4	92	286.7	267.3	52	330.6	308.3	12	374.5	349.2	72	418.3	390.1
33	243.5	227.1	93	287.4	268.0	53	331.3	309.0	13	375.2	349.9	73	419.1	390.8
34	244.3	227.8	94	288.2	268.7	54	332.1	309.6	14	376.0	350.5	74	419.8	391.5
35	245.0	228.5	95	288.9	269.4	55	332.8	310.3	15	376.6	351.2	75	420.5	392.2
36	245.7	229.2	96	289.6	270.1	56	333.5	311.0	16	377.4	351.9	76	421.3	392.8
37	246.5	229.8	97	290.4	270.8	57	334.3	311.7	17	378.2	352.6	77	422.0	393.5
38	247.2	230.5	98	291.1	271.4	58	335.0	312.4	18	378.9	353.3	78	422.7	394.2
39	247.9	231.2	99	291.8	272.1	59	335.7	313.0	19	379.6	354.0	79	423.5	394.9
40	248.7	231.9	400	292.6	272.8	60	336.5	313.7	20	380.3	354.6	80	424.2	395.6
341	249.4	232.6	401	293.3	273.5	461	337.2	314.4	521	381.1	355.3	581	424.9	396.2
42	250.1	233.2	02	294.0	274.2	62	337.9	315.1	22	381.8	356.0	82	425.7	396.9
43	250.9	233.9	03	294.7	274.9	63	338.7	315.8	23	382.6	356.7	83	426.4	397.6
44	251.6	234.6	04	295.5	275.5	64	339.4	316.5	24	383.3	357.4	84	427.1	398.3
45	252.3	235.3	05	296.2	276.2	65	340.1	317.1	25	384.0	358.1	85	427.9	399.0
46	253.1	236.0	06	296.9	276.9	66	340.8	317.8	26	384.7	358.7	86	428.6	399.6
47	253.8	236.7	07	297.7	277.6	67	341.6	318.5	27	385.5	359.4	87	429.3	400.3
48	254.5	237.3	08	298.4	278.3	68	342.3	319.2	28	386.2	360.1	88	430.1	401.0
49	255.3	238.0	09	299.1	278.9	69	343.0	319.9	29	386.9	360.8	89	430.8	401.7
50	256.0	238.7	10	299.9	279.6	70	343.7	320.5	30	387.6	361.5	90	431.5	402.4
351	256.7	239.4	411	300.6	280.3	471	344.5	321.2	531	388.4	362.1	591	432.3	403.1
52	257.4	240.1	12	301.3	281.0	72	345.2	321.9	32	389.1	362.8	92	433.0	403.7
53	258.2	240.8	13	302.1	281.7	73	345.9	322.6	33	389.9	363.5	93	433.7	404.4
54	258.9	241.4	14	302.8	282.4	74	346.7	323.3	34	390.6	364.2	94	434.5	405.1
55	259.6	242.1	15	303.5	283.0	75	347.4	324.0	35	391.3	364.9	95	435.2	405.8
56	260.4	242.8	16	304.3	283.7	76	348.1	324.6	36	392.0	365.5	96	435.9	406.5
57	261.1	243.5	17	305.0	284.4	77	348.9	325.3	37	392.8	366.2	97	436.7	407.2
58	261.8	244.2	18	305.7	285.1	78	349.6	326.0	38	393.5	366.9	98	437.4	407.8
59	262.6	244.8	19	306.4	285.8	79	350.3	326.7	39	394.2	367.6	99	438.1	408.5
60	263.3	245.5	20	307.2	286.4	80	351.1	327.4	40	394.9	368.3	600	438.8	409.2
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

47° (133°, 227°, 313°).

TABLE 2.

Difference of Latitude and Departure for 44° (136°, 224°, 316°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	0.7	0.7	61	43.9	42.4	121	87.0	84.1	181	130.2	125.7	241	173.4	167.4
2	1.4	1.4	62	44.6	43.1	22	87.8	84.7	82	130.9	126.4	42	174.1	168.1
3	2.2	2.1	63	45.3	43.8	23	88.5	85.4	83	131.6	127.1	43	174.8	168.8
4	2.9	2.8	64	46.0	44.5	24	89.2	86.1	84	132.4	127.8	44	175.5	169.5
5	3.6	3.5	65	46.8	45.2	25	89.9	86.8	85	133.1	128.5	45	176.2	170.2
6	4.3	4.2	66	47.5	45.8	26	90.6	87.5	86	133.8	129.2	46	177.0	170.9
7	5.0	4.9	67	48.2	46.5	27	91.4	88.2	87	134.5	129.9	47	177.7	171.6
8	5.8	5.6	68	48.9	47.2	28	92.1	88.9	88	135.2	130.6	48	178.4	172.3
9	6.5	6.3	69	49.6	47.9	29	92.8	89.6	89	136.0	131.3	49	179.1	173.0
10	7.2	6.9	70	50.4	48.6	30	93.5	90.3	90	136.7	132.0	50	179.8	173.7
11	7.9	7.6	71	51.1	49.3	131	94.2	91.0	191	137.4	132.7	251	180.6	174.4
12	8.6	8.3	72	51.8	50.0	32	95.0	91.7	92	138.1	133.4	52	181.3	175.1
13	9.4	9.0	73	52.5	50.7	33	95.7	92.4	93	138.8	134.1	53	182.0	175.7
14	10.1	9.7	74	53.2	51.4	34	96.4	93.1	94	139.6	134.8	54	182.7	176.4
15	10.8	10.4	75	54.0	52.1	35	97.1	93.8	95	140.3	135.5	55	183.4	177.1
16	11.5	11.1	76	54.7	52.8	36	97.8	94.5	96	141.0	136.2	56	184.2	177.8
17	12.2	11.8	77	55.4	53.5	37	98.5	95.2	97	141.7	136.8	57	184.9	178.5
18	12.9	12.5	78	56.1	54.2	38	99.3	95.9	98	142.4	137.5	58	185.6	179.2
19	13.7	13.2	79	56.8	54.9	39	100.0	96.6	99	143.1	138.2	59	186.3	179.9
20	14.4	13.9	80	57.5	55.6	40	100.7	97.3	200	143.9	138.9	60	187.0	180.6
21	15.1	14.6	81	58.3	56.3	141	101.4	97.9	201	144.6	139.6	261	187.7	181.3
22	15.8	15.3	82	59.0	57.0	42	102.1	98.6	02	145.3	140.3	62	188.5	182.0
23	16.5	16.0	83	59.7	57.7	43	102.9	99.3	03	146.0	141.0	63	189.2	182.7
24	17.3	16.7	84	60.4	58.4	44	103.6	100.0	04	146.7	141.7	64	189.9	183.4
25	18.0	17.4	85	61.1	59.0	45	104.3	100.7	05	147.5	142.4	65	190.6	184.1
26	18.7	18.1	86	61.9	59.7	46	105.0	101.4	06	148.2	143.1	66	191.3	184.8
27	19.4	18.8	87	62.6	60.4	47	105.7	102.1	07	148.9	143.8	67	192.1	185.5
28	20.1	19.5	88	63.3	61.1	48	106.5	102.8	08	149.6	144.5	68	192.8	186.2
29	20.9	20.1	89	64.0	61.8	49	107.2	103.5	09	150.3	145.2	69	193.5	186.9
30	21.6	20.8	90	64.7	62.5	50	107.9	104.2	10	151.1	145.9	70	194.2	187.6
31	22.3	21.5	91	65.5	63.2	151	108.6	104.9	211	151.8	146.6	271	194.9	188.3
32	23.0	22.2	92	66.2	63.9	52	109.3	105.6	12	152.5	147.3	72	195.7	188.9
33	23.7	22.9	93	66.9	64.6	53	110.1	106.3	13	153.2	148.0	73	196.4	189.6
34	24.5	23.6	94	67.6	65.3	54	110.8	107.0	14	153.9	148.7	74	197.1	190.3
35	25.2	24.3	95	68.3	66.0	55	111.5	107.7	15	154.7	149.4	75	197.8	191.0
36	25.9	25.0	96	69.1	66.7	56	112.2	108.4	16	155.4	150.0	76	198.5	191.7
37	26.6	25.7	97	69.8	67.4	57	112.9	109.1	17	156.1	150.7	77	199.3	192.4
38	27.3	26.4	98	70.5	68.1	58	113.7	109.8	18	156.8	151.4	78	200.0	193.1
39	28.1	27.1	99	71.2	68.8	59	114.4	110.5	19	157.5	152.1	79	200.7	193.8
40	28.8	27.8	100	71.9	69.5	60	115.1	111.1	20	158.3	152.8	80	201.4	194.5
41	29.5	28.5	101	72.7	70.2	161	115.8	111.8	221	159.0	153.5	281	202.1	195.2
42	30.2	29.2	02	73.4	70.9	62	116.5	112.5	22	159.7	154.2	82	202.9	195.9
43	30.9	29.9	03	74.1	71.5	63	117.3	113.2	23	160.4	154.9	83	203.6	196.6
44	31.7	30.6	04	74.8	72.2	64	118.0	113.9	24	161.1	155.6	84	204.3	197.3
45	32.4	31.3	05	75.5	72.9	65	118.7	114.6	25	161.9	156.3	85	205.0	198.0
46	33.1	32.0	06	76.3	73.6	66	119.4	115.3	26	162.6	157.0	86	205.7	198.7
47	33.8	32.6	07	77.0	74.3	67	120.1	116.0	27	163.3	157.7	87	206.5	199.4
48	34.5	33.3	08	77.7	75.0	68	120.8	116.7	28	164.0	158.4	88	207.2	200.1
49	35.2	34.0	09	78.4	75.7	69	121.6	117.4	29	164.7	159.1	89	207.9	200.8
50	36.0	34.7	10	79.1	76.4	70	122.3	118.1	30	165.4	159.8	90	208.6	201.5
51	36.7	35.4	111	79.8	77.1	171	123.0	118.8	231	166.2	160.5	291	209.3	202.1
52	37.4	36.1	12	80.6	77.8	72	123.7	119.5	32	166.9	161.2	92	210.0	202.8
53	38.1	36.8	13	81.3	78.5	73	124.4	120.2	33	167.6	161.9	93	210.8	203.5
54	38.8	37.5	14	82.0	79.2	74	125.2	120.9	34	168.3	162.6	94	211.5	204.2
55	39.6	38.2	15	82.7	79.9	75	125.9	121.6	35	169.0	163.2	95	212.2	204.9
56	40.3	38.9	16	83.4	80.6	76	126.6	122.3	36	169.8	163.9	96	212.9	205.6
57	41.0	39.6	17	84.2	81.3	77	127.3	123.0	37	170.5	164.6	97	213.6	206.3
58	41.7	40.3	18	84.9	82.0	78	128.0	123.6	38	171.2	165.3	98	214.4	207.0
59	42.4	41.0	19	85.6	82.7	79	128.8	124.3	39	171.9	166.0	99	215.1	207.7
60	43.2	41.7	20	86.3	83.4	80	129.5	125.0	40	172.6	166.7	300	215.8	206.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

46° (134°, 226°, 314°).

TABLE 2.

Difference of Latitude and Departure for 44° (136°, 224°, 316°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep
301	216.5	209.1	361	259.7	250.8	421	302.8	292.5	481	346.0	334.1	541	389.2	375.
02	217.2	209.8	62	260.4	251.5	22	303.6	293.2	82	346.7	334.8	42	389.9	376.
03	218.0	210.5	63	261.1	252.2	23	304.3	293.8	83	347.4	335.5	43	390.6	377.
04	218.7	211.2	64	261.8	252.9	24	305.0	294.5	84	348.2	336.2	44	391.3	377.
05	219.4	211.9	65	262.6	253.6	25	305.7	295.2	85	348.9	336.9	45	392.0	378.
06	220.1	212.6	66	263.3	254.3	26	306.4	295.9	86	349.6	337.6	46	392.8	379.
07	220.8	213.3	67	264.0	254.9	27	307.2	296.6	87	350.3	338.3	47	393.5	380.
08	221.6	214.0	68	264.7	255.6	28	307.9	297.3	88	351.0	339.0	48	394.2	380.
09	222.3	214.7	69	265.4	256.3	29	308.6	298.0	89	351.7	339.7	49	394.9	381.
10	223.0	215.4	70	266.2	257.0	30	309.3	298.7	90	352.5	340.4	50	395.6	382.
311	223.7	216.0	371	266.9	257.7	431	310.0	299.4	491	353.2	341.1	551	396.4	382.
12	224.4	216.7	72	267.6	258.4	32	310.8	300.1	92	353.9	341.8	52	397.1	383.
13	225.2	217.4	73	268.3	259.1	33	311.5	300.8	93	354.6	342.5	53	397.8	384.
14	225.9	218.1	74	269.0	259.8	34	312.2	301.5	94	355.3	343.2	54	398.5	384.
15	226.6	218.8	75	269.8	260.5	35	312.9	302.2	95	356.1	343.9	55	399.2	385.
16	227.3	219.5	76	270.5	261.2	36	313.6	302.9	96	356.8	344.6	56	400.0	386.
17	228.0	220.2	77	271.2	261.9	37	314.4	303.6	97	357.5	345.2	57	400.7	386.
18	228.8	220.9	78	271.9	262.6	38	315.1	304.3	98	358.2	345.9	58	401.4	387.
19	229.5	221.6	79	272.6	263.3	39	315.8	305.0	99	358.9	346.6	59	402.1	388.
20	230.2	222.3	80	273.4	264.0	40	316.5	305.7	500	359.7	347.3	60	402.8	389.
321	230.9	223.0	381	274.1	264.7	441	317.2	306.4	501	360.4	348.0	561	403.6	389.
22	231.6	223.7	82	274.8	265.4	42	318.0	307.0	02	361.1	348.7	62	404.3	390.
23	232.3	224.4	83	275.5	266.1	43	318.7	307.7	03	361.8	349.4	63	405.0	391.
24	233.1	225.1	84	276.2	266.8	44	319.4	308.4	04	362.5	350.1	64	405.7	391.
25	233.8	225.8	85	276.9	267.5	45	320.1	309.1	05	363.3	350.8	65	406.4	392.
26	234.5	226.5	86	277.7	268.1	46	320.8	309.8	06	364.0	351.5	66	407.2	393.
27	235.2	227.2	87	278.4	268.8	47	321.5	310.5	07	364.7	352.2	67	407.9	393.
28	235.9	227.9	88	279.1	269.5	48	322.3	311.2	08	365.4	352.9	68	408.6	394.
29	236.7	228.6	89	279.8	270.2	49	323.0	311.9	09	366.1	353.6	69	409.3	395.
30	237.4	229.2	90	280.5	270.9	50	323.7	312.6	10	366.9	354.3	70	410.0	396.
331	238.1	229.9	391	281.3	271.6	451	324.4	313.3	511	367.6	355.0	571	410.7	396.
32	238.8	230.6	92	282.0	272.3	52	325.2	314.0	12	368.3	355.7	72	411.5	397.
33	239.5	231.3	93	282.7	273.0	53	325.9	314.7	13	369.0	356.4	73	412.2	398.
34	240.3	232.0	94	283.4	273.7	54	326.6	315.4	14	369.7	357.1	74	412.9	398.
35	241.0	232.7	95	284.1	274.4	55	327.3	316.1	15	370.5	357.8	75	413.6	399.
36	241.7	233.4	96	284.9	275.1	56	328.0	316.8	16	371.2	358.4	76	414.3	400.
37	242.4	234.1	97	285.6	275.8	57	328.7	317.5	17	371.9	359.1	77	415.1	400.
38	243.1	234.8	98	286.3	276.5	58	329.5	318.2	18	372.6	359.8	78	415.8	401.
39	243.9	235.5	99	287.0	277.2	59	330.2	318.9	19	373.3	360.5	79	416.5	402.
40	244.6	236.2	400	287.7	277.9	60	330.9	319.6	20	374.1	361.2	80	417.2	402.
341	245.3	236.9	401	288.5	278.6	461	331.6	320.2	521	374.8	361.9	581	417.9	403.
42	246.0	237.6	02	289.2	279.3	62	332.3	320.9	22	375.5	362.6	82	418.7	404.
43	246.7	238.3	03	289.9	280.0	63	333.1	321.6	23	376.2	363.3	83	419.4	405.
44	247.5	239.0	04	290.6	280.7	64	333.8	322.3	24	376.9	364.0	84	420.1	405.
45	248.2	239.7	05	291.3	281.3	65	334.5	323.0	25	377.7	364.7	85	420.8	406.
46	248.9	240.4	06	292.1	282.0	66	335.2	323.7	26	378.4	365.4	86	421.5	407.
47	249.6	241.1	07	292.8	282.7	67	335.9	324.4	27	379.1	366.1	87	422.3	407.
48	250.3	241.7	08	293.5	283.4	68	336.7	325.1	28	379.8	366.8	88	423.0	408.
49	251.1	242.4	09	294.2	284.1	69	337.4	325.8	29	380.5	367.5	89	423.7	409.
50	251.8	243.1	10	294.9	284.8	70	338.1	326.5	30	381.2	368.2	90	424.4	409.
351	252.5	243.8	411	295.7	285.5	471	338.8	327.2	531	382.0	368.9	591	425.1	410.
52	253.2	244.5	12	296.4	286.2	72	339.5	327.9	32	382.7	369.6	92	425.9	411.
53	253.9	245.2	13	297.1	286.9	73	340.3	328.6	33	383.4	370.3	93	426.6	411.
54	254.6	245.9	14	297.8	287.6	74	341.0	329.3	34	384.1	371.0	94	427.3	412.
55	255.4	246.6	15	298.5	288.3	75	341.7	330.0	35	384.8	371.7	95	428.0	413.
56	256.1	247.3	16	299.2	289.0	76	342.4	330.7	36	385.6	372.4	96	428.7	414.
57	256.8	248.0	17	300.0	289.7	77	343.1	331.4	37	386.3	373.1	97	429.5	414.
58	257.5	248.7	18	300.7	290.4	78	343.8	332.1	38	387.0	373.7	98	430.2	415.
59	258.2	249.4	19	301.4	291.1	79	344.6	332.7	39	387.7	374.4	99	430.9	416.
60	259.0	250.1	20	302.1	291.8	80	345.3	333.4	40	388.4	375.1	600	431.6	416.
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

46° (134°, 226°, 314°).

TABLE 2.

Difference of Latitude and Departure for 45° (135°, 225°, 315°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	0.7	0.7	61	43.1	43.1	121	85.6	85.6	181	128.0	128.0	241	170.4	170.4
2	1.4	1.4	62	43.8	43.8	22	86.3	86.3	82	128.7	128.7	42	171.1	171.1
3	2.1	2.1	63	44.5	44.5	23	87.0	87.0	83	129.4	129.4	43	171.8	171.8
4	2.8	2.8	64	45.3	45.3	24	87.7	87.7	84	130.1	130.1	44	172.5	172.5
5	3.5	3.5	65	46.0	46.0	25	88.4	88.4	85	130.8	130.8	45	173.2	173.2
6	4.2	4.2	66	46.7	46.7	26	89.1	89.1	86	131.5	131.5	46	173.9	173.9
7	4.9	4.9	67	47.4	47.4	27	89.8	89.8	87	132.2	132.2	47	174.7	174.7
8	5.7	5.7	68	48.1	48.1	28	90.5	90.5	88	132.9	132.9	48	175.4	175.4
9	6.4	6.4	69	48.8	48.8	29	91.2	91.2	89	133.6	133.6	49	176.1	176.1
10	7.1	7.1	70	49.5	49.5	30	91.9	91.9	90	134.4	134.4	50	176.8	176.8
11	7.8	7.8	71	50.2	50.2	131	92.6	92.6	191	135.1	135.1	251	177.5	177.5
12	8.5	8.5	72	50.9	50.9	32	93.3	93.3	92	135.8	135.8	52	178.2	178.2
13	9.2	9.2	73	51.6	51.6	33	94.0	94.0	93	136.5	136.5	53	178.9	178.9
14	9.9	9.9	74	52.3	52.3	34	94.8	94.8	94	137.2	137.2	54	179.6	179.6
15	10.6	10.6	75	53.0	53.0	35	95.5	95.5	95	137.9	137.9	55	180.3	180.3
16	11.3	11.3	76	53.7	53.7	36	96.2	96.2	96	138.6	138.6	56	181.0	181.0
17	12.0	12.0	77	54.4	54.4	37	96.9	96.9	97	139.3	139.3	57	181.7	181.7
18	12.7	12.7	78	55.2	55.2	38	97.6	97.6	98	140.0	140.0	58	182.4	182.4
19	13.4	13.4	79	55.9	55.9	39	98.3	98.3	99	140.7	140.7	59	183.1	183.1
20	14.1	14.1	80	56.6	56.6	40	99.0	99.0	200	141.4	141.4	60	183.8	183.8
21	14.8	14.8	81	57.3	57.3	141	99.7	99.7	201	142.1	142.1	261	184.6	184.6
22	15.6	15.6	82	58.0	58.0	42	100.4	100.4	02	142.8	142.8	62	185.3	185.3
23	16.3	16.3	83	58.7	58.7	43	101.1	101.1	03	143.5	143.5	63	186.0	186.0
24	17.0	17.0	84	59.4	59.4	44	101.8	101.8	04	144.2	144.2	64	186.7	186.7
25	17.7	17.7	85	60.1	60.1	45	102.5	102.5	05	145.0	145.0	65	187.4	187.4
26	18.4	18.4	86	60.8	60.8	46	103.2	103.2	06	145.7	145.7	66	188.1	188.1
27	19.1	19.1	87	61.5	61.5	47	103.9	103.9	07	146.4	146.4	67	188.8	188.8
28	19.8	19.8	88	62.2	62.2	48	104.7	104.7	08	147.1	147.1	68	189.5	189.5
29	20.5	20.5	89	62.9	62.9	49	105.4	105.4	09	147.8	147.8	69	190.2	190.2
30	21.2	21.2	90	63.6	63.6	50	106.1	106.1	10	148.5	148.5	70	190.9	190.9
31	21.9	21.9	91	64.3	64.3	151	106.8	106.8	211	149.2	149.2	271	191.6	191.6
32	22.6	22.6	92	65.1	65.1	52	107.5	107.5	12	149.9	149.9	72	192.3	192.3
33	23.3	23.3	93	65.8	65.8	53	108.2	108.2	13	150.6	150.6	73	193.0	193.0
34	24.0	24.0	94	66.5	66.5	54	108.9	108.9	14	151.3	151.3	74	193.7	193.7
35	24.7	24.7	95	67.2	67.2	55	109.6	109.6	15	152.0	152.0	75	194.5	194.5
36	25.5	25.5	96	67.9	67.9	56	110.3	110.3	16	152.7	152.7	76	195.2	195.2
37	26.2	26.2	97	68.6	68.6	57	111.0	111.0	17	153.4	153.4	77	195.9	195.9
38	26.9	26.9	98	69.3	69.3	58	111.7	111.7	18	154.1	154.1	78	196.6	196.6
39	27.6	27.6	99	70.0	70.0	59	112.4	112.4	19	154.9	154.9	79	197.3	197.3
40	28.3	28.3	100	70.7	70.7	60	113.1	113.1	20	155.6	155.6	80	198.0	198.0
41	29.0	29.0	101	71.4	71.4	161	113.8	113.8	221	156.3	156.3	281	198.7	198.7
42	29.7	29.7	02	72.1	72.1	62	114.6	114.6	22	157.0	157.0	82	199.4	199.4
43	30.4	30.4	03	72.8	72.8	63	115.3	115.3	23	157.7	157.7	83	200.1	200.1
44	31.1	31.1	04	73.5	73.5	64	116.0	116.0	24	158.4	158.4	84	200.8	200.8
45	31.8	31.8	05	74.2	74.2	65	116.7	116.7	25	159.1	159.1	85	201.5	201.5
46	32.5	32.5	06	75.0	75.0	66	117.4	117.4	26	159.8	159.8	86	202.2	202.2
47	33.2	33.2	07	75.7	75.7	67	118.1	118.1	27	160.5	160.5	87	202.9	202.9
48	33.9	33.9	08	76.4	76.4	68	118.8	118.8	28	161.2	161.2	88	203.6	203.6
49	34.6	34.6	09	77.1	77.1	69	119.5	119.5	29	161.9	161.9	89	204.4	204.4
50	35.4	35.4	10	77.8	77.8	70	120.2	120.2	30	162.6	162.6	90	205.1	205.1
51	36.1	36.1	111	78.5	78.5	171	120.9	120.9	231	163.3	163.3	291	205.8	205.8
52	36.8	36.8	12	79.2	79.2	72	121.6	121.6	32	164.0	164.0	92	206.5	206.5
53	37.5	37.5	13	79.9	79.9	73	122.3	122.3	33	164.8	164.8	93	207.2	207.2
54	38.2	38.2	14	80.6	80.6	74	123.0	123.0	34	165.5	165.5	94	207.9	207.9
55	38.9	38.9	15	81.3	81.3	75	123.7	123.7	35	166.2	166.2	95	208.6	208.6
56	39.6	39.6	16	82.0	82.0	76	124.5	124.5	36	166.9	166.9	96	209.3	209.3
57	40.3	40.3	17	82.7	82.7	77	125.2	125.2	37	167.6	167.6	97	210.0	210.0
58	41.0	41.0	18	83.4	83.4	78	125.9	125.9	38	168.3	168.3	98	210.7	210.7
59	41.7	41.7	19	84.1	84.1	79	126.6	126.6	39	169.0	169.0	99	211.4	211.4
60	42.4	42.4	20	84.9	84.9	80	127.3	127.3	40	169.7	169.7	300	212.1	212.1
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

45° (135°, 225°, 315°).

TABLE 2.

Difference of Latitude and Departure for 45° (135°, 225°, 315°).

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
301	212.8	212.8	361	255.3	255.3	421	297.7	297.7	481	340.1	340.1	541	382.5	382.5
02	213.5	213.5	62	256.0	256.0	22	298.4	298.4	82	340.8	340.8	42	383.2	383.2
03	214.3	214.3	63	256.7	256.7	23	299.1	299.1	83	341.5	341.5	43	383.9	383.9
04	215.0	215.0	64	257.4	257.4	24	299.8	299.8	84	342.2	342.2	44	384.7	384.7
05	215.7	215.7	65	258.1	258.1	25	300.5	300.5	85	342.9	342.9	45	385.4	385.4
06	216.4	216.4	66	258.8	258.8	26	301.2	301.2	86	343.6	343.6	46	386.1	386.1
07	217.1	217.1	67	259.5	259.5	27	301.9	301.9	87	344.3	344.3	47	386.8	386.8
08	217.8	217.8	68	260.2	260.2	28	302.6	302.6	88	345.1	345.1	48	387.5	387.5
09	218.5	218.5	69	260.9	260.9	29	303.4	303.4	89	345.8	345.8	49	388.2	388.2
10	219.2	219.2	70	261.6	261.6	30	304.1	304.1	90	346.5	346.5	50	388.9	388.9
311	219.9	219.9	371	262.3	262.3	431	304.8	304.8	491	347.2	347.2	551	389.6	389.6
12	220.6	220.6	72	263.0	263.0	32	305.5	305.5	92	347.9	347.9	52	390.3	390.3
13	221.3	221.3	73	263.8	263.8	33	306.2	306.2	93	348.6	348.6	53	391.0	391.0
14	222.0	222.0	74	264.5	264.5	34	306.9	306.9	94	349.3	349.3	54	391.7	391.7
15	222.7	222.7	75	265.2	265.2	35	307.6	307.6	95	350.0	350.0	55	392.4	392.4
16	223.4	223.4	76	265.9	265.9	36	308.3	308.3	96	350.7	350.7	56	393.1	393.1
17	224.2	224.2	77	266.6	266.6	37	309.0	309.0	97	351.4	351.4	57	393.9	393.9
18	224.9	224.9	78	267.3	267.3	38	309.7	309.7	98	352.1	352.1	58	394.6	394.6
19	225.6	225.6	79	268.0	268.0	39	310.4	310.4	99	352.8	352.8	59	395.3	395.3
20	226.3	226.3	80	268.7	268.7	40	311.1	311.1	500	353.5	353.5	60	396.0	396.0
321	227.0	227.0	381	269.4	269.4	441	311.8	311.8	501	354.3	354.3	561	396.7	396.7
22	227.7	227.7	82	270.1	270.1	42	312.5	312.5	02	355.0	355.0	62	397.4	397.4
23	228.4	228.4	83	270.8	270.8	43	313.3	313.3	03	355.7	355.7	63	398.1	398.1
24	229.1	229.1	84	271.5	271.5	44	314.0	314.0	04	356.4	356.4	64	398.8	398.8
25	229.8	229.8	85	272.2	272.2	45	314.7	314.7	05	357.1	357.1	65	399.5	399.5
26	230.5	230.5	86	272.9	272.9	46	315.4	315.4	06	357.8	357.8	66	400.2	400.2
27	231.2	231.2	87	273.7	273.7	47	316.1	316.1	07	358.5	358.5	67	400.9	400.9
28	231.9	231.9	88	274.4	274.4	48	316.8	316.8	08	359.2	359.2	68	401.6	401.6
29	232.6	232.6	89	275.1	275.1	49	317.5	317.5	09	359.9	359.9	69	402.3	402.3
30	233.3	233.3	90	275.8	275.8	50	318.2	318.2	10	360.6	360.6	70	403.0	403.0
331	234.1	234.1	391	276.5	276.5	451	318.9	318.9	511	361.3	361.3	571	403.8	403.8
32	234.8	234.8	92	277.2	277.2	52	319.6	319.6	12	362.0	362.0	72	404.5	404.5
33	235.5	235.5	93	277.9	277.9	53	320.3	320.3	13	362.7	362.7	73	405.2	405.2
34	236.2	236.2	94	278.6	278.6	54	321.0	321.0	14	363.5	363.5	74	405.9	405.9
35	236.9	236.9	95	279.3	279.3	55	321.7	321.7	15	364.2	364.2	75	406.6	406.6
36	237.6	237.6	96	280.0	280.0	56	322.4	322.4	16	364.9	364.9	76	407.3	407.3
37	238.3	238.3	97	280.7	280.7	57	323.2	323.2	17	365.6	365.6	77	408.0	408.0
38	239.0	239.0	98	281.4	281.4	58	323.9	323.9	18	366.3	366.3	78	408.7	408.7
39	239.7	239.7	99	282.1	282.1	59	324.6	324.6	19	367.0	367.0	79	409.4	409.4
40	240.4	240.4	400	282.8	282.8	60	325.3	325.3	20	367.7	367.7	80	410.1	410.1
341	241.1	241.1	401	283.6	283.6	461	326.0	326.0	521	368.4	368.4	581	410.8	410.8
42	241.8	241.8	02	284.3	284.3	62	326.7	326.7	22	369.1	369.1	82	411.5	411.5
43	242.5	242.5	03	285.0	285.0	63	327.4	327.4	23	369.8	369.8	83	412.2	412.2
44	243.2	243.2	04	285.7	285.7	64	328.1	328.1	24	370.5	370.5	84	412.9	412.9
45	244.0	244.0	05	286.4	286.4	65	328.8	328.8	25	371.2	371.2	85	413.7	413.7
46	244.7	244.7	06	287.1	287.1	66	329.5	329.5	26	371.9	371.9	86	414.4	414.4
47	245.4	245.4	07	287.8	287.8	67	330.2	330.2	27	372.6	372.6	87	415.1	415.1
48	246.1	246.1	08	288.5	288.5	68	330.9	330.9	28	373.4	373.4	88	415.8	415.8
49	246.8	246.8	09	289.2	289.2	69	331.6	331.6	29	374.1	374.1	89	416.5	416.5
50	247.5	247.5	10	289.9	289.9	70	332.3	332.3	30	374.8	374.8	90	417.2	417.2
351	248.2	248.2	411	290.6	290.6	471	333.1	333.1	531	375.5	375.5	591	417.9	417.9
52	248.9	248.9	12	291.3	291.3	72	333.8	333.8	32	376.2	376.2	92	418.6	418.6
53	249.6	249.6	13	292.0	292.0	73	334.5	334.5	33	376.9	376.9	93	419.3	419.3
54	250.3	250.3	14	292.7	292.7	74	335.2	335.2	34	377.6	377.6	94	420.0	420.0
55	251.0	251.0	15	293.5	293.5	75	335.9	335.9	35	378.3	378.3	95	420.7	420.7
56	251.7	251.7	16	294.2	294.2	76	336.6	336.6	36	379.0	379.0	96	421.4	421.4
57	252.4	252.4	17	294.9	294.9	77	337.3	337.3	37	379.7	379.7	97	422.1	422.1
58	253.1	253.1	18	295.6	295.6	78	338.0	338.0	38	380.4	380.4	98	422.8	422.8
59	253.9	253.9	19	296.3	296.3	79	338.7	338.7	39	381.1	381.1	99	423.6	423.6
60	254.6	254.6	20	297.0	297.0	80	339.4	339.4	40	381.8	381.8	600	424.3	424.3
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

45° (135°, 225°, 315°).

TABLE 3.

Meridional Parts, or Increased Latitudes.

Comp. $\frac{1}{293.465}$

M.	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	M.
0	0.0	59.6	119.2	178.9	238.6	298.3	358.2	418.2	478.3	538.6	0
1	1.0	60.6	20.2	79.9	39.6	99.3	59.2	19.2	79.3	39.6	1
2	2.0	61.6	21.2	80.8	40.6	300.3	60.2	20.2	80.3	40.6	2
3	3.0	62.6	22.2	81.8	41.6	01.3	61.2	21.2	81.3	41.6	3
4	4.0	63.6	23.2	82.8	42.5	02.3	62.2	22.2	82.3	42.6	4
5	5.0	64.6	124.2	183.8	243.5	303.3	363.2	423.2	483.3	543.6	5
6	6.0	65.6	25.2	84.8	44.5	04.3	64.2	24.2	84.3	44.6	6
7	7.0	66.5	26.2	85.8	45.5	05.3	65.2	25.2	85.3	45.6	7
8	7.9	67.5	27.2	86.8	46.5	06.3	66.2	26.2	86.3	46.6	8
9	8.9	68.5	28.2	87.8	47.5	07.3	67.2	27.2	87.3	47.6	9
10	9.9	69.5	129.1	188.8	248.5	308.3	368.2	428.2	488.3	548.6	10
11	10.9	70.5	30.1	89.8	49.5	09.3	69.2	29.2	89.3	49.6	11
12	11.9	71.5	31.1	90.8	50.5	10.3	70.2	30.2	90.4	50.6	12
13	12.9	72.5	32.1	91.8	51.5	11.3	71.2	31.2	91.4	51.7	13
14	13.9	73.5	33.1	92.8	52.5	12.3	72.2	32.2	92.4	52.7	14
15	14.9	74.5	134.1	193.8	253.5	313.3	373.2	433.2	493.4	553.7	15
16	15.9	75.5	35.1	94.8	54.5	14.3	74.2	34.2	94.4	54.7	16
17	16.9	76.5	36.1	95.8	55.5	15.3	75.2	35.2	95.4	55.7	17
18	17.9	77.5	37.1	96.8	56.5	16.3	76.2	36.2	96.4	56.7	18
19	18.9	78.5	38.1	97.8	57.5	17.3	77.2	37.2	97.4	57.7	19
20	19.9	79.5	139.1	198.8	258.5	318.3	378.2	438.2	498.4	558.7	20
21	20.9	80.5	40.1	99.7	59.5	19.3	79.2	39.2	99.4	59.7	21
22	21.9	81.5	41.1	200.7	60.5	20.3	80.2	40.2	500.4	60.7	22
23	22.8	82.4	42.1	01.7	61.5	21.3	81.2	41.2	01.4	61.7	23
24	23.8	83.4	43.1	02.7	62.5	22.3	82.2	42.2	02.4	62.7	24
25	24.8	84.4	144.1	203.7	263.5	323.3	383.2	443.2	503.4	563.7	25
26	25.8	85.4	45.1	04.7	64.5	24.3	84.2	44.2	04.4	64.7	26
27	26.8	86.4	46.0	05.7	65.5	25.3	85.2	45.2	05.4	65.7	27
28	27.8	87.4	47.0	06.7	66.5	26.3	86.2	46.2	06.4	66.8	28
29	28.8	88.4	48.0	07.7	67.4	27.3	87.2	47.2	07.4	67.8	29
30	29.8	89.4	149.0	208.7	268.4	328.3	388.2	448.2	508.4	568.8	30
31	30.8	90.4	50.0	09.7	69.4	29.3	89.2	49.2	09.4	69.8	31
32	31.8	91.4	51.0	10.7	70.4	30.3	90.2	50.2	10.4	70.8	32
33	32.8	92.4	52.0	11.7	71.4	31.3	91.2	51.2	11.4	71.8	33
34	33.8	93.4	53.0	12.7	72.4	32.3	92.2	52.2	12.4	72.8	34
35	34.8	94.4	154.0	213.7	273.4	333.3	393.2	453.2	513.4	573.8	35
36	35.8	95.4	55.0	14.7	74.4	34.3	94.2	54.3	14.5	74.8	36
37	36.7	96.4	56.0	15.7	75.4	35.3	95.2	55.3	15.5	75.8	37
38	37.7	97.3	57.0	16.7	76.4	36.2	96.2	56.3	16.5	76.8	38
39	38.7	98.3	58.0	17.7	77.4	37.2	97.2	57.3	17.5	77.8	39
40	39.7	99.3	159.0	218.7	278.4	338.2	398.2	458.3	518.5	578.8	40
41	40.7	100.3	60.0	19.7	79.4	39.2	99.2	59.3	19.5	79.9	41
42	41.7	01.3	61.0	20.6	80.4	40.2	400.2	60.3	20.5	80.9	42
43	42.7	02.3	62.0	21.6	81.4	41.2	01.2	61.3	21.5	81.9	43
44	43.7	03.3	63.0	22.6	82.4	42.2	02.2	62.3	22.5	82.9	44
45	44.7	104.3	164.0	223.6	283.4	343.2	403.2	463.3	523.5	583.9	45
46	45.7	05.3	65.0	24.6	84.4	44.2	04.2	64.3	24.5	84.9	46
47	46.7	06.3	66.0	25.6	85.4	45.2	05.2	65.3	25.5	85.9	47
48	47.7	07.3	67.0	26.6	86.4	46.2	06.2	66.3	26.5	86.9	48
49	48.7	08.3	68.0	27.6	87.4	47.2	07.2	67.3	27.5	87.9	49
50	49.7	109.3	168.9	228.6	288.4	348.2	408.2	468.3	528.5	588.9	50
51	50.7	10.3	69.9	29.6	89.4	49.2	09.2	69.3	29.5	89.9	51
52	51.6	11.3	70.9	30.6	90.4	50.2	10.2	70.3	30.5	90.9	52
53	52.6	12.3	71.9	31.6	91.4	51.2	11.2	71.3	31.5	91.9	53
54	53.6	13.2	72.9	32.6	92.4	52.2	12.2	72.3	32.5	93.0	54
55	54.6	114.2	173.9	233.6	293.4	353.2	413.2	473.3	533.5	594.0	55
56	55.6	15.2	74.9	34.6	94.4	54.2	14.2	74.3	34.6	95.0	56
57	56.6	16.2	75.9	35.6	95.4	55.2	15.2	75.3	35.6	96.0	57
58	57.6	17.2	76.9	36.6	96.3	56.2	16.2	76.3	36.6	97.0	58
59	58.6	18.2	77.9	37.6	97.3	57.2	17.2	77.3	37.6	98.0	59
M.	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	M.

TABLE 3.

Meridional Parts, or Increased Latitudes.

Comp. $\frac{1}{293.465}$

M.	10°	11°	12°	13°	14°	15°	16°	17°	18°	19°	M.
0	599.0	659.6	720.5	781.5	842.8	904.4	966.3	1028.5	1091.0	1153.9	0
1	600.0	60.6	21.5	82.5	43.9	05.4	67.3	29.5	92.0	54.9	1
2	01.0	61.7	22.5	83.6	44.9	06.5	68.3	30.5	93.1	56.0	2
3	02.0	62.7	23.5	84.6	45.9	07.5	69.4	31.6	94.1	57.0	3
4	03.0	63.7	24.5	85.6	46.9	08.5	70.4	32.6	95.2	58.1	4
5	604.1	664.7	725.5	786.6	847.9	909.6	971.4	1033.7	1096.2	1159.1	5
6	05.1	65.7	26.6	87.6	49.0	10.6	72.5	34.7	97.3	60.2	6
7	06.1	66.7	27.6	88.7	50.0	11.6	73.5	35.7	98.3	61.2	7
8	07.1	67.7	28.6	89.7	51.0	12.6	74.6	36.8	99.4	62.3	8
9	08.1	68.7	29.6	90.7	52.0	13.7	75.6	37.8	1100.4	63.3	9
10	609.1	669.8	730.6	791.7	853.1	914.7	976.6	1038.9	1101.4	1164.4	10
11	10.1	70.8	31.6	92.7	54.1	15.7	77.7	39.9	02.5	65.4	11
12	11.1	71.8	32.7	93.8	55.1	16.8	78.7	40.9	03.5	66.5	12
13	12.1	72.8	33.7	94.8	56.1	17.8	79.7	42.0	04.6	67.5	13
14	13.1	73.8	34.7	95.8	57.2	18.8	80.8	43.0	05.6	68.6	14
15	614.1	674.8	735.7	796.8	858.2	919.8	981.8	1044.1	1106.7	1169.7	15
16	15.2	75.8	36.7	97.8	59.2	20.9	82.8	45.1	07.7	70.7	16
17	16.2	76.8	37.7	98.9	60.2	21.9	83.9	46.1	08.8	71.8	17
18	17.2	77.9	38.8	99.9	61.3	22.9	84.9	47.2	09.8	72.8	18
19	18.2	78.9	39.8	800.9	62.3	24.0	85.9	48.2	10.9	73.9	19
20	619.2	679.9	740.8	801.9	863.3	925.0	987.0	1049.3	1111.9	1174.9	20
21	20.2	80.9	41.8	02.9	64.3	26.0	88.0	50.3	13.0	76.0	21
22	21.2	81.9	42.8	04.0	65.4	27.1	89.0	51.3	14.0	77.0	22
23	22.2	82.9	43.8	05.0	66.4	28.1	90.1	52.4	15.0	78.1	23
24	23.2	83.9	44.9	06.0	67.4	29.1	91.1	53.4	16.1	79.1	24
25	624.2	684.9	745.9	807.0	868.5	930.1	992.1	1054.5	1117.1	1180.2	25
26	25.3	86.0	46.9	08.1	69.5	31.2	93.2	55.5	18.2	81.2	26
27	26.3	87.0	47.9	09.1	70.5	32.2	94.2	56.6	19.2	82.3	27
28	27.3	88.0	48.9	10.1	71.5	33.2	95.3	57.6	20.3	83.3	28
29	28.3	89.0	49.9	11.1	72.6	34.3	96.3	58.6	21.3	84.4	29
30	629.3	690.0	751.0	812.1	873.6	935.3	997.3	1059.7	1122.4	1185.5	30
31	30.3	91.0	52.0	13.2	74.6	36.3	98.4	60.7	23.4	86.5	31
32	31.3	92.0	53.0	14.2	75.6	37.4	99.4	61.8	24.5	87.6	32
33	32.3	93.1	54.0	15.2	76.7	38.4	1000.4	62.8	25.5	88.6	33
34	33.3	94.1	55.0	16.2	77.7	39.4	01.5	63.9	26.6	89.7	34
35	634.3	695.1	756.0	817.3	878.7	940.5	1002.5	1064.9	1127.6	1190.7	35
36	35.4	96.1	57.1	18.3	79.7	41.5	03.6	65.9	28.7	91.8	36
37	36.4	97.1	58.1	19.3	80.8	42.5	04.6	67.0	29.7	92.8	37
38	37.4	98.1	59.1	20.3	81.8	43.6	05.6	68.0	30.8	93.9	38
39	38.4	99.1	60.1	21.3	82.8	44.6	06.7	69.1	31.8	95.0	39
40	639.4	700.2	761.1	822.4	883.8	945.6	1007.7	1070.1	1132.9	1196.0	40
41	40.4	01.2	62.2	23.4	84.9	46.7	08.7	71.2	33.9	97.1	41
42	41.4	02.2	63.2	24.4	85.9	47.7	09.8	72.2	35.0	98.1	42
43	42.4	03.2	64.2	25.4	86.9	48.7	10.8	73.2	36.0	99.2	43
44	43.4	04.2	65.2	26.5	88.0	49.7	11.8	74.3	37.1	1200.2	44
45	644.5	705.2	766.2	827.5	889.0	950.8	1012.9	1075.3	1138.1	1201.3	45
46	45.5	06.2	67.3	28.5	90.0	51.8	13.9	76.4	39.2	02.3	46
47	46.5	07.3	68.3	29.5	91.0	52.8	15.0	77.4	40.2	03.4	47
48	47.5	08.3	69.3	30.5	92.1	53.9	16.0	78.5	41.3	04.5	48
49	48.5	09.3	70.3	31.6	93.1	54.9	17.0	79.5	42.3	05.5	49
50	649.5	710.3	771.3	832.6	894.1	955.9	1018.1	1080.5	1143.4	1206.6	50
51	50.5	11.3	72.3	33.6	95.2	57.0	19.1	81.6	44.4	07.6	51
52	51.5	12.3	73.4	34.6	96.2	58.0	20.2	82.6	45.5	08.7	52
53	52.5	13.4	74.4	35.7	97.2	59.0	21.2	83.7	46.5	09.7	53
54	53.6	14.4	75.4	36.7	98.2	60.1	22.2	84.7	47.6	10.8	54
55	654.6	715.4	776.4	837.7	899.3	961.1	1023.3	1085.8	1148.6	1211.8	55
56	55.6	16.4	77.4	38.7	900.3	62.1	24.3	86.8	49.7	12.9	56
57	56.6	17.4	78.5	39.8	01.3	63.2	25.3	87.9	50.7	14.0	57
58	57.6	18.4	79.5	40.8	02.3	64.2	26.4	88.9	51.8	15.0	58
59	58.6	19.4	80.5	41.8	03.4	65.2	27.4	89.9	52.8	16.1	59
M.	10°	11°	12°	13°	14°	15°	16°	17°	18°	19°	M.

TABLE 3.

Meridional Parts, or Increased Latitudes.

Comp. $\frac{1}{293.465}$

M.	20°	21°	22°	23°	24°	25°	26°	27°	28°	29°	M.
0	1217.1	1280.8	1344.9	1409.5	1474.5	1540.1	1606.2	1672.9	1740.2	1808.1	0
1	18.2	81.9	46.0	10.6	75.6	41.2	07.3	74.0	41.3	09.2	1
2	19.3	82.9	47.1	11.6	76.7	42.3	08.4	75.1	42.4	10.4	2
3	20.3	84.0	48.1	12.7	77.8	43.4	09.5	76.2	43.6	11.5	3
4	21.4	85.1	49.2	13.8	78.9	44.5	10.6	77.4	44.7	12.6	4
5	1222.4	1286.1	1350.3	1414.9	1480.0	1545.6	1611.7	1678.5	1745.8	1813.8	5
6	23.5	87.2	51.4	16.0	81.1	46.7	12.9	79.6	46.9	14.9	6
7	24.5	88.3	52.4	17.1	82.2	47.8	14.0	80.7	48.1	16.1	7
8	25.6	89.3	53.5	18.1	83.3	48.9	15.1	81.8	49.2	17.2	8
9	26.7	90.4	54.6	19.2	84.3	50.0	16.2	82.9	50.3	18.3	9
10	1227.7	1291.5	1355.7	1420.3	1485.4	1551.1	1617.3	1684.1	1751.5	1819.5	10
11	28.8	92.5	56.7	21.4	86.5	52.2	18.4	85.2	52.6	20.6	11
12	29.8	93.6	57.8	22.5	87.6	53.3	19.5	86.3	53.7	21.8	12
13	30.9	94.7	58.9	23.5	88.7	54.4	20.6	87.4	54.8	22.9	13
14	32.0	95.7	59.9	24.6	89.8	55.5	21.7	88.5	56.0	24.0	14
15	1233.0	1296.8	1361.0	1425.7	1490.9	1556.6	1622.8	1689.7	1757.1	1825.2	15
16	34.1	97.9	62.1	26.8	92.0	57.7	23.9	90.8	58.2	26.3	16
17	35.1	98.9	63.2	27.9	93.1	58.8	25.0	91.9	59.4	27.5	17
18	36.2	1300.0	64.2	29.0	94.2	59.9	26.2	93.0	60.5	28.6	18
19	37.3	01.1	65.3	30.0	95.2	61.0	27.3	94.1	61.6	29.7	19
20	1238.3	1302.1	1366.4	1431.1	1496.3	1562.1	1628.4	1695.3	1762.7	1830.9	20
21	39.4	03.2	67.5	32.2	97.4	63.2	29.5	96.4	63.9	32.0	21
22	40.4	04.3	68.5	33.3	98.5	64.3	30.6	97.5	65.0	33.2	22
23	41.5	05.3	69.6	34.4	99.6	65.4	31.7	98.6	66.1	34.3	23
24	42.6	06.4	70.7	35.4	1500.7	66.5	32.8	99.7	67.3	35.4	24
25	1243.6	1307.5	1371.8	1436.5	1501.8	1567.6	1633.9	1700.9	1768.4	1836.6	25
26	44.7	08.5	72.8	37.6	02.9	68.7	35.0	02.0	69.5	37.7	26
27	45.7	09.6	73.9	38.7	04.0	69.8	36.1	03.1	70.7	38.9	27
28	46.8	10.7	75.0	39.8	05.1	70.9	37.3	04.2	71.8	40.0	28
29	47.9	11.7	76.1	40.9	06.2	72.0	38.4	05.3	72.9	41.2	29
30	1248.9	1312.8	1377.1	1442.0	1507.3	1573.1	1639.5	1706.5	1774.1	1842.3	30
31	50.0	13.9	78.2	43.0	08.4	74.2	40.6	07.6	75.2	43.4	31
32	51.0	14.9	79.3	44.1	09.4	75.3	41.7	08.7	76.3	44.6	32
33	52.1	16.0	80.4	45.2	10.5	76.4	42.8	09.8	77.4	45.7	33
34	53.2	17.1	81.5	46.3	11.6	77.5	43.9	10.9	78.6	46.9	34
35	1254.2	1318.2	1382.5	1447.4	1512.7	1578.6	1645.0	1712.1	1779.7	1848.0	35
36	55.3	19.2	83.6	48.5	13.8	79.7	46.2	13.2	80.8	49.2	36
37	56.4	20.3	84.7	49.5	14.9	80.8	47.3	14.3	82.0	50.3	37
38	57.4	21.4	85.8	50.6	16.0	81.9	48.4	15.4	83.1	51.4	38
39	58.5	22.4	86.8	51.7	17.1	83.0	49.5	16.6	84.2	52.6	39
40	1259.5	1323.5	1387.9	1452.8	1518.2	1584.1	1650.6	1717.7	1785.4	1853.7	40
41	60.6	24.6	89.0	53.9	19.3	85.2	51.7	18.8	86.5	54.9	41
42	61.7	25.6	90.1	55.0	20.4	86.3	52.8	19.9	87.6	56.0	42
43	62.7	26.7	91.1	56.1	21.5	87.4	53.9	21.1	88.8	57.2	43
44	63.8	27.8	92.2	57.1	22.6	88.5	55.1	22.2	89.9	58.3	44
45	1264.9	1328.9	1393.3	1458.2	1523.7	1589.6	1656.2	1723.3	1791.1	1859.5	45
46	65.9	29.9	94.4	59.3	24.8	90.7	57.3	24.4	92.2	60.6	46
47	67.0	31.0	95.5	60.4	25.9	91.8	58.4	25.5	93.3	61.8	47
48	68.0	32.1	96.5	61.5	27.0	92.9	59.5	26.7	94.5	62.9	48
49	69.1	33.1	97.6	62.6	28.0	94.1	60.6	27.8	95.6	64.0	49
50	1270.2	1334.2	1398.7	1463.7	1529.1	1595.2	1661.7	1728.9	1796.7	1865.2	50
51	71.2	35.3	99.8	64.8	30.2	96.3	62.9	30.0	97.9	66.3	51
52	72.3	36.3	1400.9	65.8	31.3	97.4	64.0	31.2	99.0	67.5	52
53	73.4	37.4	01.9	66.9	32.4	98.5	65.1	32.3	1800.1	68.6	53
54	74.4	38.5	03.0	68.0	33.5	99.6	66.2	33.4	01.3	69.8	54
55	1275.5	1339.6	1404.1	1469.1	1534.6	1600.7	1667.3	1734.5	1802.4	1870.9	55
56	76.6	40.6	05.2	70.2	35.7	01.8	68.4	35.7	03.5	72.1	56
57	77.6	41.7	06.2	71.3	36.8	02.9	69.5	36.8	04.7	73.2	57
58	78.7	42.8	07.3	72.4	37.9	04.0	70.7	37.9	05.8	74.4	58
59	79.7	43.8	08.4	73.5	39.0	05.1	71.8	39.1	07.0	75.5	59
M.	20°	21°	22°	23°	24°	25°	26°	27°	28°	29°	M.

TABLE 3.

Meridional Parts, or Increased Latitudes.

Comp. $\frac{1}{293.465}$

M.	30°	31°	32°	33°	34°	35°	36°	37°	38°	39°	M.
0	1876.7	1946.0	2016.0	2086.8	2158.4	2230.9	2304.2	2378.5	2453.8	2530.2	0
1	77.8	47.1	17.2	88.0	59.6	32.1	05.5	79.8	55.1	31.5	1
2	79.0	48.3	18.3	89.2	60.8	33.3	06.7	81.0	56.4	32.8	2
3	80.1	49.4	19.5	90.3	62.0	34.5	07.9	82.3	57.6	34.0	3
4	81.3	50.6	20.7	91.5	63.2	35.7	09.2	83.5	58.9	35.3	4
5	1882.4	1951.8	2021.9	2092.7	2164.4	2236.9	2310.4	2384.8	2460.2	2536.6	5
6	83.6	52.9	23.0	93.9	65.6	38.2	11.6	86.0	61.4	37.9	6
7	84.7	54.1	24.2	95.1	66.8	39.4	12.9	87.3	62.7	39.2	7
8	85.9	55.3	25.4	96.3	68.0	40.6	14.1	88.5	64.0	40.5	8
9	87.0	56.4	26.6	97.5	69.2	41.8	15.3	89.8	65.2	41.7	9
10	1888.2	1957.6	2027.7	2098.7	2170.4	2243.0	2316.5	2391.0	2466.5	2543.0	10
11	89.3	58.7	28.9	99.8	71.6	44.2	17.8	92.3	67.8	44.3	11
12	90.5	59.9	30.1	2101.0	72.8	45.5	19.0	93.5	69.0	45.6	12
13	91.6	61.1	31.3	02.2	74.0	46.7	20.3	94.8	70.3	46.9	13
14	92.8	62.2	32.4	03.4	75.2	47.9	21.5	96.0	71.6	48.2	14
15	1893.9	1963.4	2033.6	2104.6	2176.4	2249.1	2322.7	2397.3	2472.8	2549.5	15
16	95.1	64.6	34.8	05.8	77.6	50.3	24.0	98.5	74.1	50.7	16
17	96.2	65.7	36.0	07.0	78.8	51.6	25.2	99.8	75.4	52.0	17
18	97.4	66.9	37.1	08.2	80.0	52.8	26.4	2401.0	76.6	53.3	18
19	98.5	68.1	38.3	09.4	81.2	54.0	27.7	02.3	77.9	54.6	19
20	1899.7	1969.2	2039.5	2110.6	2182.5	2255.2	2328.9	2403.5	2479.2	2555.9	20
21	1900.8	70.4	40.7	11.8	83.7	56.4	30.1	04.8	80.4	57.2	21
22	02.0	71.5	41.8	12.9	84.9	57.7	31.4	06.0	81.7	58.5	22
23	03.1	72.7	43.0	14.1	86.1	58.9	32.6	07.3	83.0	59.8	23
24	04.3	73.9	44.2	15.3	87.3	60.1	33.8	08.5	84.3	61.0	24
25	1905.5	1975.0	2045.4	2116.5	2188.5	2261.3	2335.1	2409.8	2485.5	2562.3	25
26	06.6	76.2	46.6	17.7	89.7	62.5	36.3	11.1	86.8	63.6	26
27	07.8	77.4	47.7	18.9	90.9	63.8	37.6	12.3	88.1	64.9	27
28	08.9	78.5	48.9	20.1	92.1	65.0	38.8	13.6	89.3	66.2	28
29	10.1	79.7	50.1	21.3	93.3	66.2	40.0	14.8	90.6	67.5	29
30	1911.2	1980.9	2051.3	2122.5	2194.5	2267.4	2341.3	2416.1	2491.9	2568.8	30
31	12.4	82.0	52.5	23.7	95.7	68.7	42.5	17.3	93.2	70.1	31
32	13.5	83.2	53.6	24.9	96.9	69.9	43.7	18.6	94.4	71.4	32
33	14.7	84.4	54.8	26.1	98.1	71.1	45.0	19.8	95.7	72.7	33
34	15.8	85.5	56.0	27.3	99.4	72.3	46.2	21.1	97.0	73.9	34
35	1917.0	1986.7	2057.2	2128.5	2200.6	2273.5	2347.5	2422.3	2498.3	2575.2	35
36	18.2	87.9	58.4	29.6	01.8	74.8	48.7	23.6	99.5	76.5	36
37	19.3	89.1	59.5	30.8	03.0	76.0	49.9	24.9	2500.8	77.8	37
38	20.5	90.2	60.7	32.0	04.2	77.2	51.2	26.1	02.1	79.1	38
39	21.6	91.4	61.9	33.2	05.4	78.4	52.4	27.4	03.4	80.4	39
40	1922.8	1992.6	2063.1	2134.4	2206.6	2279.7	2353.7	2428.6	2504.6	2581.7	40
41	23.9	93.7	64.3	35.6	07.8	80.9	54.9	29.9	05.9	83.0	41
42	25.1	94.9	65.5	36.8	09.0	82.1	56.1	31.2	07.2	84.3	42
43	26.3	96.1	66.6	38.0	10.2	83.3	57.4	32.4	08.5	85.6	43
44	27.4	97.2	67.8	39.2	11.5	84.6	58.6	33.7	09.7	86.9	44
45	1928.6	1998.4	2069.0	2140.4	2212.7	2285.8	2359.9	2434.9	2511.0	2588.2	45
46	29.7	99.6	70.2	41.6	13.9	87.0	61.1	36.2	12.3	89.5	46
47	30.9	2000.7	71.4	42.8	15.1	88.3	62.4	37.4	13.6	90.8	47
48	32.0	01.9	72.6	44.0	16.3	89.5	63.6	38.7	14.8	92.1	48
49	33.2	03.1	73.7	45.2	17.5	90.7	64.8	40.0	16.1	93.4	49
50	1934.4	2004.3	2074.9	2146.4	2218.7	2291.9	2366.1	2441.2	2517.4	2594.7	50
51	35.5	05.4	76.1	47.6	19.9	93.2	67.3	42.5	18.7	96.0	51
52	36.7	06.6	77.3	48.8	21.1	94.4	68.6	43.7	20.0	97.3	52
53	37.8	07.8	78.5	50.0	22.4	95.6	69.8	45.0	21.2	98.5	53
54	39.0	08.9	79.7	51.2	23.6	96.9	71.1	46.3	22.5	99.8	54
55	1940.2	2010.1	2080.8	2152.4	2224.8	2298.1	2372.3	2447.5	2523.8	2601.1	55
56	41.3	11.3	82.0	53.6	26.0	99.3	73.6	48.8	25.1	02.4	56
57	42.5	12.5	83.2	54.8	27.2	2300.5	74.8	50.1	26.4	03.7	57
58	43.6	13.6	84.4	56.0	28.4	01.8	76.1	51.3	27.6	05.0	58
59	44.8	14.8	85.6	57.2	29.6	03.0	77.3	52.5	28.9	06.3	59
M.	30°	31°	32°	33°	34°	35°	36°	37°	38°	39°	M.

TABLE 3.

Meridional Parts, or Increased Latitudes.

Comp. $\frac{1}{293.465}$

M.	40°	41°	42°	43°	44°	45°	46°	47°	48°	49°	M.
0	2607.6	2686.2	2766.0	2847.1	2929.5	3013.4	3098.7	3185.6	3274.1	3364.4	0
1	08.9	87.6	67.4	48.5	30.9	14.8	3100.1	87.1	75.6	65.9	1
2	10.2	88.9	68.7	49.9	32.3	16.2	01.6	88.5	77.1	67.4	2
3	11.5	90.2	70.1	51.2	33.7	17.6	03.0	90.0	78.6	69.0	3
4	12.8	91.5	71.4	52.6	35.1	19.0	04.4	91.4	80.1	70.5	4
5	2614.1	2692.8	2772.8	2853.9	2936.5	3020.4	3105.9	3192.9	3281.6	3372.0	5
6	15.4	94.2	74.1	55.3	37.9	21.8	07.3	94.4	83.1	73.5	6
7	16.8	95.5	75.4	56.7	39.3	23.3	08.8	95.8	84.6	75.1	7
8	18.1	96.8	76.8	58.0	40.6	24.7	10.2	97.3	86.1	76.6	8
9	19.4	98.1	78.1	59.4	42.0	26.1	11.6	98.8	87.6	78.1	9
10	2620.7	2699.5	2779.5	2860.8	2943.4	3027.5	3113.1	3200.2	3289.0	3379.6	10
11	22.0	2700.8	80.8	62.1	44.8	28.9	14.5	01.7	90.5	81.2	11
12	23.3	02.1	82.2	63.5	46.2	30.3	16.0	03.2	92.0	82.7	12
13	24.6	03.4	83.5	64.9	47.6	31.7	17.4	04.6	93.5	84.2	13
14	25.9	04.8	84.8	66.2	49.0	33.2	18.8	06.1	95.0	85.7	14
15	2627.2	2706.1	2786.2	2867.6	2950.4	3034.6	3120.3	3207.6	3296.5	3387.3	15
16	28.5	07.4	87.5	69.0	51.8	36.0	21.7	09.0	98.0	88.8	16
17	29.8	08.7	88.9	70.3	53.2	37.4	23.2	10.5	99.5	90.3	17
18	31.1	10.1	90.2	71.7	54.5	38.8	24.6	12.0	3301.0	91.8	18
19	32.4	11.4	91.6	73.1	55.9	40.2	26.0	13.4	02.5	93.4	19
20	2633.7	2712.7	2792.9	2874.4	2957.3	3041.7	3127.5	3214.9	3304.0	3394.9	20
21	35.0	14.0	94.3	75.8	58.7	43.1	28.9	16.4	05.5	96.4	21
22	36.3	15.4	95.6	77.2	60.1	44.5	30.4	17.9	07.0	98.0	22
23	37.6	16.7	97.0	78.6	61.5	45.9	31.8	19.3	08.5	99.5	23
24	38.9	18.0	98.3	79.9	62.9	47.3	33.3	20.8	10.0	3401.0	24
25	2640.2	2719.3	2799.7	2881.3	2964.3	3048.7	3134.7	3222.3	3311.5	3402.6	25
26	41.6	20.7	2801.0	82.7	65.7	50.2	36.2	23.7	13.0	04.1	26
27	42.9	22.0	02.4	84.0	67.1	51.6	37.6	25.2	14.5	05.6	27
28	44.2	23.3	03.7	85.4	68.5	53.0	39.0	26.7	16.0	07.2	28
29	45.5	24.7	05.1	86.8	69.9	54.4	40.5	28.2	17.5	08.7	29
30	2646.8	2726.0	2806.4	2888.2	2971.3	3055.9	3141.9	3229.6	3319.0	3410.2	30
31	48.1	27.3	07.8	89.5	72.7	57.3	43.4	31.1	20.5	11.8	31
32	49.4	28.6	09.1	90.9	74.1	58.7	44.8	32.6	22.1	13.3	32
33	50.7	30.0	10.5	92.3	75.5	60.1	46.3	34.1	23.6	14.8	33
34	52.0	31.3	11.8	93.7	76.9	61.5	47.7	35.6	25.1	16.4	34
35	2653.3	2732.6	2813.2	2895.0	2978.3	3063.0	3149.2	3237.0	3326.6	3417.9	35
36	54.7	34.0	14.5	96.4	79.7	64.4	50.6	38.5	28.1	19.5	36
37	56.0	35.3	15.9	97.8	81.1	65.8	52.1	40.0	29.6	21.0	37
38	57.3	36.6	17.2	99.2	82.5	67.2	53.5	41.5	31.1	22.5	38
39	58.6	38.0	18.6	2900.5	83.9	68.7	55.0	42.9	32.6	24.1	39
40	2659.9	2739.3	2820.0	2901.9	2985.3	3070.1	3156.4	3244.4	3334.1	3425.6	40
41	61.2	40.6	21.3	03.3	86.7	71.5	57.9	45.9	35.6	27.2	41
42	62.5	42.0	22.7	04.7	88.1	72.9	59.4	47.4	37.1	28.7	42
43	63.9	43.3	24.0	06.1	89.5	74.4	60.8	48.9	38.6	30.2	43
44	65.2	44.6	25.4	07.4	90.9	75.8	62.3	50.3	40.2	31.8	44
45	2666.5	2746.0	2826.7	2908.8	2992.3	3077.2	3163.7	3251.8	3341.7	3433.3	45
46	67.8	47.3	28.1	10.2	93.7	78.7	65.2	53.3	43.2	34.9	46
47	69.1	48.6	29.4	11.6	95.1	80.1	66.6	54.8	44.7	36.4	47
48	70.4	50.0	30.8	13.0	96.5	81.5	68.1	56.3	46.2	38.0	48
49	71.7	51.3	32.2	14.3	97.9	82.9	69.5	57.8	47.7	39.5	49
50	2673.1	2752.7	2833.5	2915.7	2999.3	3084.4	3171.0	3259.3	3349.2	3441.0	50
51	74.4	54.0	34.9	17.1	3000.7	85.8	72.5	60.7	50.8	42.6	51
52	75.7	55.3	36.2	18.5	02.1	87.2	73.9	62.2	52.3	44.1	52
53	77.0	56.7	37.6	19.9	03.5	88.7	75.4	63.7	53.8	45.7	53
54	78.3	58.0	39.0	21.2	04.9	90.1	76.8	65.2	55.3	47.2	54
55	2679.6	2759.3	2840.3	2922.6	3006.3	3091.5	3178.3	3266.7	3356.8	3448.8	55
56	81.0	60.7	41.7	24.0	07.7	93.0	79.7	68.2	58.3	50.3	56
57	82.3	62.0	43.0	25.4	09.2	94.4	81.2	69.7	59.9	51.9	57
58	83.6	63.4	44.4	26.8	10.6	95.8	82.7	71.1	61.4	53.4	58
59	84.9	64.7	45.8	28.2	12.0	97.3	84.1	72.6	62.9	55.0	59
M.	40°	41°	42°	43°	44°	45°	46°	47°	48°	49°	M.

TABLE 3.

Meridional Parts, or Increased Latitudes.

Comp. $\frac{1}{293.465}$

M.	50°	51°	52°	53°	54°	55°	56°	57°	58°	59°	M.
0	3456.5	3550.6	3646.7	3745.1	3845.7	3948.8	4054.5	4163.0	4274.4	4389.1	0
1	58.1	52.2	48.4	46.7	47.4	50.5	56.3	64.8	76.3	91.0	1
2	59.6	53.8	50.0	48.4	49.1	52.3	58.1	66.6	78.2	92.9	2
3	61.2	55.4	51.6	50.0	50.8	54.0	59.8	68.5	80.1	94.9	3
4	62.7	56.9	53.2	51.7	52.5	55.7	61.6	70.3	82.0	96.8	4
5	3464.3	3558.5	3654.8	3753.4	3854.2	3957.5	4063.4	4172.1	4283.9	4398.8	5
6	65.9	60.1	56.5	55.0	55.9	59.2	65.2	74.0	85.7	4400.7	6
7	67.4	61.7	58.1	56.7	57.6	61.0	67.0	75.8	87.6	02.6	7
8	69.0	63.3	59.7	58.3	59.3	62.7	68.8	77.7	89.5	04.6	8
9	70.5	64.9	61.3	60.0	61.0	64.5	70.6	79.5	91.4	06.5	9
10	3472.1	3566.5	3663.0	3761.7	3862.7	3966.2	4072.4	4181.3	4293.3	4408.5	10
11	73.6	68.1	64.6	63.3	64.4	68.0	74.2	83.2	95.2	10.4	11
12	75.2	69.7	66.2	65.0	66.1	69.7	76.0	85.0	97.1	12.4	12
13	76.7	71.3	67.9	66.7	67.8	71.5	77.7	86.9	99.0	14.3	13
14	78.3	72.8	69.5	68.3	69.5	73.2	79.5	88.7	4300.9	16.3	14
15	3479.9	3574.4	3671.1	3770.0	3871.2	3975.0	4081.3	4190.6	4302.8	4418.2	15
16	81.4	76.0	72.7	71.7	72.9	76.7	83.1	92.4	04.7	20.2	16
17	83.0	77.6	74.4	73.3	74.6	78.5	84.9	94.2	06.6	22.1	17
18	84.5	79.2	76.0	75.0	76.3	80.2	86.7	96.1	08.5	24.1	18
19	86.1	80.8	77.6	76.7	78.1	82.0	88.5	97.9	10.4	26.1	19
20	3487.7	3582.4	3679.3	3778.3	3879.8	3983.7	4090.3	4199.8	4312.3	4428.0	20
21	89.2	84.0	80.9	80.0	81.5	85.5	92.1	4201.6	14.2	30.0	21
22	90.8	85.6	82.5	81.7	83.2	87.2	93.9	03.5	16.1	31.9	22
23	92.4	87.2	84.2	83.3	84.9	89.0	95.7	05.3	18.0	33.9	23
24	93.9	88.8	85.8	85.0	86.6	90.7	97.5	07.2	19.9	35.8	24
25	3495.5	3590.4	3687.4	3786.7	3888.3	3992.5	4099.3	4209.0	4321.8	4437.8	25
26	97.1	92.0	89.1	88.4	90.0	94.3	4101.1	10.9	23.7	39.8	26
27	98.6	93.6	90.7	90.0	91.8	96.0	02.9	12.8	25.6	41.7	27
28	3500.2	95.2	92.3	91.7	93.5	97.8	04.8	14.6	27.5	43.7	28
29	01.8	96.8	94.0	93.4	95.2	99.5	06.6	16.5	29.4	45.7	29
30	3503.3	3598.4	3695.6	3795.1	3896.9	4001.3	4108.4	4218.3	4331.3	4447.6	30
31	04.9	3600.0	97.3	96.8	98.6	03.1	10.2	20.2	33.2	49.6	31
32	06.5	01.6	98.9	98.4	3900.4	04.8	12.0	22.0	35.2	51.6	32
33	08.0	03.2	3700.5	3800.1	02.1	06.6	13.8	23.9	37.1	53.5	33
34	09.6	04.8	02.2	01.8	03.8	08.3	15.6	25.8	39.0	55.5	34
35	3511.2	3606.4	3703.8	3803.5	3905.5	4010.1	4117.4	4227.6	4340.9	4457.5	35
36	12.7	08.0	05.5	05.1	07.2	11.9	19.2	29.5	42.8	59.4	36
37	14.3	09.6	07.1	06.8	09.0	13.6	21.0	31.3	44.7	61.4	37
38	15.9	11.2	08.7	08.5	10.7	15.4	22.9	33.2	46.6	63.4	38
39	17.5	12.8	10.4	10.2	12.4	17.2	24.7	35.1	48.6	65.4	39
40	3519.0	3614.5	3712.0	3811.9	3914.1	4018.9	4126.5	4236.9	4350.5	4467.3	40
41	20.6	16.1	13.7	13.6	15.9	20.7	28.3	38.8	52.4	69.3	41
42	22.2	17.7	15.3	15.2	17.6	22.5	30.1	40.7	54.3	71.3	42
43	23.7	19.3	17.0	17.0	19.3	24.3	31.9	42.5	56.2	73.3	43
44	25.3	20.9	18.6	18.6	21.0	26.0	33.8	44.4	58.2	75.3	44
45	3526.9	3622.5	3720.3	3820.3	3922.8	4027.8	4135.6	4246.3	4360.1	4477.2	45
46	28.5	24.1	21.9	22.0	24.5	29.6	37.4	48.1	62.0	79.2	46
47	30.1	25.7	23.6	23.7	26.2	31.4	39.2	50.0	63.9	81.2	47
48	31.6	27.3	25.2	25.4	28.0	33.1	41.0	51.9	65.9	83.2	48
49	33.2	29.0	26.9	27.1	29.7	34.9	42.9	53.8	67.8	85.2	49
50	3534.8	3630.6	3728.5	3828.7	3931.4	4036.7	4144.7	4255.6	4369.7	4487.2	50
51	36.4	32.2	30.2	30.4	33.2	38.5	46.5	57.5	71.7	89.1	51
52	37.9	33.8	31.8	32.1	34.9	40.2	48.3	59.4	73.6	91.1	52
53	39.5	35.4	33.5	33.8	36.6	42.0	50.2	61.3	75.5	93.1	53
54	41.1	37.0	35.1	35.5	38.4	43.8	52.0	63.1	77.4	95.1	54
55	3542.7	3638.6	3736.8	3837.2	3940.1	4045.6	4153.8	4265.0	4379.4	4497.1	55
56	44.3	40.3	38.4	38.9	41.8	47.4	55.7	66.9	81.3	99.1	56
57	45.9	41.9	40.1	40.6	43.6	49.1	57.5	68.8	83.2	4501.1	57
58	47.4	43.5	41.7	42.3	45.3	50.9	59.3	70.7	85.2	03.1	58
59	49.0	45.1	43.4	45.0	47.0	52.7	61.1	72.5	87.1	05.1	59
M.	50°	51°	52°	53°	54°	55°	56°	57°	58°	59°	M.

TABLE 3.

Meridional Parts, or Increased Latitudes.

Comp. $\frac{1}{293.465}$

M.	60°	61°	62°	63°	64°	65°	66°	67°	68°	69°	M.
0	4507.1	4628.7	4754.3	4884.1	5018.4	5157.6	5302.1	5452.4	5609.1	5772.7	0
1	09.1	30.8	56.4	86.3	20.6	59.9	04.6	55.0	11.8	75.5	1
2	11.1	32.9	58.6	88.5	22.9	62.3	07.0	57.6	14.4	78.3	2
3	13.1	34.9	60.7	90.7	25.2	64.7	09.5	60.1	17.1	81.1	3
4	15.1	37.0	62.8	92.9	27.5	67.0	11.9	62.7	19.8	83.8	4
5	4517.1	4639.0	4764.9	4895.1	5029.8	5169.4	5314.4	5465.2	5622.4	5786.6	5
6	19.1	41.1	67.1	97.3	32.1	71.8	16.9	67.8	25.1	89.4	6
7	21.1	43.2	69.2	99.5	34.3	74.2	19.3	70.4	27.8	92.2	7
8	23.1	45.2	71.3	4901.7	36.6	76.5	21.8	72.9	30.5	95.1	8
9	25.1	47.3	73.5	03.9	38.9	78.9	24.3	75.5	33.2	97.9	9
10	4527.1	4649.4	4775.6	4906.1	5041.2	5181.3	5326.7	5477.1	5635.9	5800.7	10
11	29.1	51.5	77.8	08.3	43.5	83.7	29.2	80.7	38.5	03.5	11
12	31.1	53.5	79.9	10.5	45.8	86.0	31.7	83.2	41.2	06.3	12
13	33.1	55.6	82.0	12.8	48.1	88.4	34.2	85.8	43.9	09.1	13
14	35.1	57.7	84.2	15.0	50.4	90.8	36.6	88.4	46.6	11.9	14
15	4537.1	4659.7	4786.3	4917.2	5052.7	5193.2	5339.1	5491.0	5649.3	5814.7	15
16	39.2	61.8	88.5	19.4	55.0	95.6	41.6	93.6	52.0	17.6	16
17	41.2	63.9	90.6	21.6	57.3	98.0	44.1	96.2	54.7	20.4	17
18	43.2	66.0	92.8	23.9	59.6	5200.4	46.6	98.7	57.4	23.2	18
19	45.2	68.1	94.9	26.1	61.9	02.7	49.1	5501.3	60.1	26.0	19
20	4547.2	4670.1	4797.1	4928.3	5064.2	5205.1	5351.5	5503.9	5662.8	5828.9	20
21	49.2	72.2	99.2	30.5	66.5	07.5	54.0	06.5	65.5	31.7	21
22	51.3	74.3	4801.4	32.8	68.8	09.9	56.5	09.1	68.2	34.5	22
23	53.3	76.4	03.5	35.0	71.1	12.3	59.0	11.7	70.9	37.4	23
24	55.3	78.5	05.7	37.2	73.4	14.7	61.5	14.3	73.7	40.2	24
25	4557.3	4680.6	4807.8	4939.4	5075.7	5217.1	5364.0	5516.9	5676.4	5843.0	25
26	59.3	82.6	10.0	41.7	78.1	19.5	66.5	19.5	79.1	45.9	26
27	61.4	84.7	12.1	43.9	80.4	21.9	69.0	22.1	81.8	48.7	27
28	63.4	86.8	14.3	46.1	82.7	24.3	71.5	24.7	84.5	51.6	28
29	65.4	88.9	16.5	48.4	85.0	26.7	74.0	27.3	87.3	54.4	29
30	4567.4	4691.0	4818.6	4950.6	5087.3	5229.1	5376.5	5529.9	5690.0	5857.3	30
31	69.5	93.1	20.8	52.9	89.6	31.6	79.0	32.5	92.7	60.1	31
32	71.5	95.2	23.0	55.1	92.0	34.0	81.5	35.2	95.4	63.0	32
33	73.5	97.3	25.1	57.3	94.3	36.4	84.0	37.8	98.2	65.9	33
34	75.6	99.4	27.3	59.6	96.6	38.8	86.5	40.4	5700.9	68.7	34
35	4577.6	4701.5	4829.5	4961.8	5098.9	5241.2	5389.1	5543.0	5703.6	5871.6	35
36	79.6	03.6	31.6	64.1	5101.3	43.6	91.6	45.6	06.4	74.4	36
37	81.7	05.7	33.8	66.3	03.6	46.0	94.1	48.3	09.1	77.3	37
38	83.7	07.8	36.0	68.6	05.9	48.5	96.6	50.9	11.9	80.2	38
39	85.7	09.9	38.1	70.8	08.3	50.9	99.1	53.5	14.6	83.1	39
40	4587.8	4712.0	4840.3	4973.1	5110.6	5253.3	5401.6	5556.1	5717.3	5885.9	40
41	89.8	14.1	42.5	75.3	12.9	55.7	04.2	58.8	20.1	88.8	41
42	91.8	16.2	44.7	77.6	15.3	58.2	06.7	61.4	22.8	91.7	42
43	93.9	18.3	46.8	79.8	17.6	60.6	09.2	64.0	25.6	94.6	43
44	95.9	20.4	49.0	82.1	19.9	63.0	11.8	66.7	28.3	97.4	44
45	4598.0	4722.5	4851.2	4984.3	5122.3	5265.4	5414.3	5569.3	5731.1	5900.3	45
46	4600.0	24.6	53.4	86.6	24.6	67.9	16.8	71.9	33.9	03.2	46
47	02.1	26.7	55.6	88.9	27.0	70.3	19.3	74.6	36.6	06.1	47
48	04.1	28.9	57.8	91.1	29.3	72.8	21.9	77.2	39.4	09.0	48
49	06.1	31.0	59.9	93.4	31.7	75.2	24.4	79.9	42.1	11.9	49
50	4608.2	4733.1	4862.1	4995.6	5134.0	5277.6	5427.0	5582.5	5744.9	5914.8	50
51	10.2	35.2	64.3	97.9	36.4	80.1	29.5	85.2	47.7	17.7	51
52	12.3	37.3	66.5	5000.2	38.7	82.5	32.0	87.8	50.4	20.6	52
53	14.3	39.4	68.7	02.4	41.1	85.0	34.6	90.5	53.2	23.5	53
54	16.4	41.6	70.9	04.7	43.4	87.4	37.1	93.1	56.0	26.4	54
55	4618.5	4743.7	4873.1	5007.0	5145.8	5289.8	5439.7	5595.8	5758.8	5929.3	55
56	20.5	45.8	75.3	09.3	48.1	92.3	42.2	98.4	61.5	32.2	56
57	22.6	47.9	77.5	11.5	50.5	94.7	44.8	5601.1	64.3	35.1	57
58	24.6	50.0	79.7	13.8	52.8	97.2	47.3	03.8	67.1	38.1	58
59	26.7	52.2	81.9	16.1	55.2	99.7	49.9	06.4	69.9	41.0	59
M.	60°	61°	62°	63°	64°	65°	66°	67°	68°	69°	M.

TABLE 3.

Meridional Parts, or Increased Latitudes.

Comp. $\frac{1}{298.465}$

M.	70°	71°	72°	73°	74°	75°	76°	77°	78°	79°	M.
0	5943.9	6123.5	6312.5	6512.0	6723.2	6947.7	7187.3	7444.4	7721.6	8022.7	0
1	46.8	26.6	15.8	15.4	26.8	51.6	91.5	48.8	26.4	27.9	1
2	49.7	29.7	19.0	18.9	30.5	55.4	95.6	53.3	31.3	33.2	2
3	52.7	32.8	22.3	22.3	34.1	59.3	99.7	57.7	36.1	38.5	3
4	55.6	35.8	25.5	25.7	37.7	63.2	7203.9	62.2	40.9	43.7	4
5	5958.5	6138.9	6328.8	6529.1	6741.4	6967.1	7208.0	7466.7	7745.8	8049.0	5
6	61.5	42.0	32.0	32.6	45.0	70.9	12.2	71.1	50.6	54.3	6
7	64.4	45.1	35.3	36.0	48.7	74.8	16.4	75.6	55.5	59.6	7
8	67.3	48.2	38.5	39.5	52.3	78.7	20.5	80.1	60.3	64.9	8
9	70.3	51.3	41.8	42.9	56.0	82.6	24.7	84.6	65.2	70.2	9
10	5973.2	6154.4	6345.0	6546.4	6759.7	6986.5	7228.9	7489.1	7770.1	8075.5	10
11	76.2	57.5	48.3	49.8	63.3	90.4	33.1	93.6	74.9	80.8	11
12	79.1	60.6	51.6	53.3	67.0	94.3	37.3	98.1	79.8	86.1	12
13	82.1	63.7	54.8	56.7	70.7	98.3	41.5	7502.6	84.7	91.5	13
14	85.0	66.8	58.1	60.2	74.3	7002.2	45.7	07.1	89.6	96.8	14
15	5988.0	6169.9	6361.4	6563.7	6778.0	7006.1	7249.9	7511.7	7794.5	8102.2	15
16	90.9	73.0	64.7	67.1	81.7	10.0	54.1	16.2	99.4	07.5	16
17	93.9	76.1	67.9	70.6	85.4	14.0	58.3	20.7	7804.3	12.9	17
18	96.9	79.2	71.2	74.1	89.1	17.9	62.5	25.3	09.3	18.3	18
19	99.8	82.3	74.5	77.6	92.8	21.8	66.7	29.8	14.2	23.7	19
20	6002.8	6185.5	6377.8	6581.0	6796.5	7025.8	7270.9	7534.4	7819.1	8129.1	20
21	05.8	88.6	81.1	84.5	6800.2	29.7	75.2	38.9	24.1	34.5	21
22	08.7	91.7	84.4	88.0	03.9	33.7	79.4	43.5	29.0	39.9	22
23	11.7	94.8	87.7	91.5	07.6	37.7	83.7	48.1	34.0	45.3	23
24	14.7	98.0	91.0	95.0	11.3	41.6	87.9	52.7	39.0	50.8	24
25	6017.7	6201.1	6394.3	6598.5	6815.0	7045.6	7292.2	7557.3	7844.0	8156.2	25
26	20.7	04.2	97.6	6602.0	18.8	49.6	96.4	61.8	48.9	61.6	26
27	23.6	07.4	6400.9	05.5	22.5	53.5	7300.7	66.4	53.9	67.1	27
28	26.6	10.5	04.3	09.0	26.2	57.5	05.0	71.0	58.9	72.6	28
29	29.6	13.7	07.6	12.5	30.0	61.5	09.2	75.7	63.9	78.0	29
30	6032.6	6216.8	6410.9	6616.1	6833.7	7065.5	7313.5	7580.3	7868.9	8183.5	30
31	35.6	20.0	14.2	19.6	37.4	69.5	17.8	84.9	74.0	89.0	31
32	38.6	23.1	17.6	23.1	41.2	73.5	22.1	89.5	79.0	94.5	32
33	41.6	26.3	20.9	26.6	44.9	77.5	26.4	94.2	84.0	8200.0	33
34	44.6	29.4	24.2	30.2	48.7	81.5	30.7	98.8	89.1	05.5	34
35	6047.6	6232.6	6427.6	6633.7	6852.4	7085.5	7335.0	7603.4	7894.1	8211.1	35
36	50.6	35.8	30.9	37.2	56.2	89.5	39.3	08.1	99.2	16.6	36
37	53.6	38.9	34.2	40.8	60.0	93.5	43.6	12.8	7904.2	22.1	37
38	56.6	42.1	37.6	44.3	63.7	97.6	47.9	17.4	09.3	27.7	38
39	59.7	45.3	40.9	47.9	67.5	7101.6	52.3	22.1	14.4	33.3	39
40	6062.7	6248.4	6444.3	6651.4	6871.3	7105.6	7356.6	7626.8	7919.4	8238.8	40
41	65.7	51.6	47.6	55.0	75.1	09.7	60.9	31.4	24.5	44.4	41
42	68.7	54.8	51.0	58.5	78.9	13.7	65.3	36.1	29.6	50.0	42
43	71.7	58.0	54.4	62.1	82.6	17.8	69.6	40.8	34.7	55.6	43
44	74.8	61.2	57.7	65.7	86.4	21.8	74.0	45.5	39.9	61.2	44
45	6077.8	6264.4	6461.1	6669.2	6890.2	7125.9	7378.3	7650.2	7945.0	8266.8	45
46	80.8	67.6	64.5	72.8	94.0	29.9	82.7	55.0	50.1	72.4	46
47	83.9	70.8	67.8	76.4	97.8	34.0	87.1	59.7	55.2	78.1	47
48	86.9	74.0	71.2	80.0	6901.7	38.1	91.4	64.4	60.4	83.7	48
49	89.9	77.2	74.6	83.5	05.5	42.2	95.8	69.1	65.5	89.3	49
50	6093.0	6280.4	6478.0	6687.1	6909.3	7146.2	7400.2	7673.9	7970.7	8295.0	50
51	96.0	83.6	81.4	90.7	13.1	50.3	04.6	78.6	75.9	8300.7	51
52	99.1	86.8	84.8	94.3	16.9	54.4	09.0	83.4	81.0	06.4	52
53	6102.1	90.0	88.2	97.9	20.8	58.5	13.4	88.1	86.2	12.0	53
54	05.2	93.2	91.6	6701.5	24.6	62.6	17.8	92.9	91.4	17.7	54
55	6108.2	6296.4	6495.0	6705.1	6928.4	7166.7	7422.2	7697.7	7996.6	8323.4	55
56	11.3	99.6	98.4	08.7	32.3	70.8	26.6	7702.5	8001.8	29.2	56
57	14.3	6302.9	6501.8	12.4	36.1	75.0	31.1	07.2	07.0	34.9	57
58	17.4	06.1	05.2	16.0	40.0	79.1	35.5	12.0	12.2	40.6	58
59	20.5	09.3	08.6	19.6	43.8	83.2	39.9	16.8	17.5	46.4	59
M.	70°	71°	72°	73°	74°	75°	76°	77°	78°	79°	M.

TABLE 4.

Length of a Degree in Latitude and Longitude.

Lat.	Degree of Long.			Degree of Lat.			Lat.
	Naut. miles.	Statute miles.	Meters.	Naut. miles.	Statute miles.	Meters.	
°							°
0	60.068	69.172	111 321	59.661	68.704	110 567	0
1	0.059	9.162	1 304	.661	.704	568	1
2	0.031	9.130	1 253	.662	.705	569	2
3	59.986	9.078	1 169	.663	.706	570	3
4	9.922	9.005	1 051	.664	.708	573	4
5	59.840	68.911	110 900	59.666	68.710	110 576	5
6	9.741	8.795	0 715	.668	.712	580	6
7	9.622	8.660	0 497	.670	.715	584	7
8	9.487	8.504	0 245	.673	.718	589	8
9	9.333	8.326	109 959	.676	.721	595	9
10	59.161	68.129	109 641	59.680	68.725	110 601	10
11	8.971	7.910	9 289	.684	.730	608	11
12	8.764	7.670	8 904	.687	.734	616	12
13	8.538	7.410	8 486	.692	.739	624	13
14	8.295	7.131	8 036	.697	.744	633	14
15	58.034	66.830	107 553	59.702	68.751	110 643	15
16	7.756	6.510	7 036	.707	.757	653	16
17	7.459	6.169	6 487	.713	.764	663	17
18	7.146	5.808	5 906	.719	.771	675	18
19	6.816	5.427	5 294	.725	.778	686	19
20	56.468	65.026	104 649	59.732	68.786	110 699	20
21	6.102	4.606	3 972	.739	.794	712	21
22	5.720	4.166	3 264	.746	.802	725	22
23	5.321	3.706	2 524	.754	.811	739	23
24	4.905	3.228	1 754	.761	.820	753	24
25	54.473	62.729	100 952	59.769	68.829	110 768	25
26	4.024	2.212	0 119	.777	.839	783	26
27	3.558	1.676	99 257	.786	.848	799	27
28	3.076	1.122	8 364	.795	.858	815	28
29	2.578	0.548	7 441	.804	.869	832	29
30	52.064	59.956	96 488	59.813	68.879	110 849	30
31	1.534	9.345	5 506	.822	.890	866	31
32	0.989	8.716	4 495	.831	.901	883	32
33	0.428	8.071	3 455	.841	.912	901	33
34	49.851	7.407	2 387	.851	.923	919	34
35	49.259	56.725	91 290	59.861	68.935	110 938	35
36	8.653	6.027	0 166	.871	.946	956	36
37	8.031	5.311	89 014	.881	.958	975	37
38	7.395	4.579	7 835	.891	.969	994	38
39	6.744	3.829	6 629	.902	.981	111 013	39
40	46.079	53.063	85 396	59.912	68.993	111 033	40
41	5.399	2.281	4 137	.923	69.006	052	41
42	4.706	1.483	2 853	.933	.018	072	42
43	4.000	0.669	1 543	.944	.030	091	43
44	3.280	49.840	0 208	.954	.042	111	44
45	2.546	8.995	78 849	.965	.054	131	45

TABLE 4.

Length of a Degree in Latitude and Longitude.

Lat.	Degree of Long.			Degree of Lat.			Lat.
	Naut. miles.	Statute miles.	Meters.	Naut. miles.	Statute miles.	Meters.	
°							°
45	42.546	48.995	78 849	59.965	69.054	111 131	45
46	1.801	8.136	7 466	.976	.066	151	46
47	1.041	7.261	6 058	.987	.079	170	47
48	0.268	6.372	4 628	.997	.091	190	48
49	39.484	5.469	3 174	60.008	.103	210	49
50	38.688	44.552	71 698	60.019	69.115	111 229	50
51	7.880	3.621	0 200	.029	.127	249	51
52	7.060	2.676	68 680	.039	.139	268	52
53	6.229	1.719	7 140	.050	.151	287	53
54	5.386	0.749	5 578	.060	.163	306	54
55	34.532	39.766	63 996	60.070	69.175	111 325	55
56	3.668	8.771	2 395	.080	.086	343	56
57	2.794	7.764	0 774	.090	.197	362	57
58	1.909	6.745	59 135	.100	.209	380	58
59	1.015	5.716	7 478	.109	.220	397	59
60	30.110	34.674	55 802	60.118	69.230	111 415	60
61	29.197	3.623	4 110	.128	.241	432	61
62	8.275	2.560	2 400	.137	.251	448	62
63	7.344	1.488	0 675	.145	.261	464	63
64	6.404	0.406	48 934	.154	.271	480	64
65	25.456	29.315	47 177	60.162	69.281	111 496	65
66	4.501	8.215	5 407	.170	.290	511	66
67	3.538	7.106	3 622	.178	.299	525	67
68	2.567	5.988	1 823	.186	.308	539	68
69	1.590	4.862	0 012	.193	.316	553	69
70	20.606	23.729	38 188	60.200	69.324	111 566	70
71	19.616	2.589	6 353	.207	.332	578	71
72	8.619	1.441	4 506	.213	.340	590	72
73	7.617	0.287	2 648	.220	.347	602	73
74	6.609	19.127	0 781	.225	.354	613	74
75	15.596	17.960	28 903	60.231	69.360	111 623	75
76	4.578	6.788	7 017	.236	.366	633	76
77	3.556	5.611	5 123	.241	.372	642	77
78	2.529	4.428	3 220	.246	.377	650	78
79	1.499	3.242	1 311	.250	.382	658	79
80	10.465	12.051	19 394	60.254	69.386	111 665	80
81	9.428	10.857	7 472	.257	.390	671	81
82	8.388	9.659	5 545	.260	.394	677	82
83	7.345	8.458	3 612	.263	.397	682	83
84	6.300	7.255	1 675	.265	.400	687	84
85	5.253	6.049	9 735	60.268	69.402	111 691	85
86	4.205	4.842	7 792	.269	.404	694	86
87	3.154	3.632	5 846	.270	.405	696	87
88	2.103	2.422	3 898	.271	.407	698	88
89	1.052	1.211	1 949	.272	.407	699	89
90	0	0	0	.272	.407	699	90

TABLE 5A.

Distance of an Object by Two Bearings.

Difference between the course and second bearing, in points.	Difference between the course and first bearing, in points.													
	2		2¼		2½		2¾		3		3¼		3½	
3	1.96	1.09												
3¼	1.57	0.94	2.19	1.31										
3½	1.32	0.84	1.76	1.12	2.42	1.53								
3¾	1.14	0.76	1.47	0.99	1.94	1.30	2.64	1.77						
4	1.00	0.71	1.27	0.90	1.62	1.15	2.12	1.50	2.85	2.01				
4¼	0.90	0.66	1.12	0.83	1.40	1.04	1.77	1.31	2.29	1.69	3.05	2.26		
4½	0.81	0.63	1.00	0.77	1.23	0.95	1.53	1.18	1.91	1.48	2.45	1.90	3.25	2.51
4¾	0.74	0.60	0.91	0.73	1.10	0.89	1.34	1.08	1.65	1.32	2.05	1.65	2.61	2.10
5	0.69	0.57	0.83	0.69	1.00	0.83	1.20	1.00	1.45	1.21	1.77	1.47	2.19	1.82
5¼	0.64	0.55	0.77	0.66	0.92	0.79	1.09	0.94	1.30	1.11	1.56	1.34	1.88	1.62
5½	0.60	0.53	0.72	0.63	0.85	0.75	1.00	0.88	1.18	1.04	1.39	1.23	1.66	1.46
5¾	0.57	0.52	0.68	0.61	0.79	0.72	0.93	0.84	1.08	0.98	1.26	1.14	1.48	1.34
6	0.54	0.50	0.64	0.59	0.74	0.69	0.86	0.80	1.00	0.92	1.16	1.07	1.35	1.24
6¼	0.52	0.49	0.60	0.57	0.70	0.66	0.81	0.76	0.93	0.88	1.07	1.01	1.23	1.16
6½	0.50	0.47	0.58	0.55	0.67	0.64	0.77	0.73	0.88	0.84	1.00	0.96	1.14	1.09
6¾	0.48	0.46	0.55	0.54	0.64	0.62	0.73	0.71	0.83	0.80	0.94	0.91	1.06	1.03
7	0.46	0.45	0.53	0.52	0.61	0.60	0.69	0.68	0.79	0.77	0.89	0.87	1.00	0.98
7¼	0.45	0.44	0.51	0.51	0.59	0.58	0.67	0.66	0.75	0.74	0.84	0.83	0.94	0.93
7½	0.43	0.43	0.50	0.50	0.57	0.56	0.64	0.64	0.72	0.72	0.80	0.80	0.90	0.89
7¾	0.42	0.42	0.48	0.48	0.55	0.55	0.62	0.62	0.69	0.69	0.77	0.77	0.86	0.86
8	0.41	0.41	0.47	0.47	0.53	0.53	0.60	0.60	0.67	0.67	0.74	0.74	0.82	0.82
8¼	0.41	0.41	0.46	0.46	0.52	0.52	0.58	0.58	0.65	0.65	0.72	0.72	0.79	0.79
8½	0.40	0.40	0.45	0.45	0.51	0.51	0.57	0.57	0.63	0.63	0.69	0.69	0.76	0.76
8¾	0.39	0.39	0.45	0.44	0.50	0.50	0.56	0.55	0.61	0.61	0.68	0.67	0.74	0.73
9	0.39	0.38	0.44	0.43	0.49	0.48	0.55	0.54	0.60	0.59	0.66	0.65	0.72	0.71
9¼	0.39	0.38	0.44	0.42	0.49	0.47	0.54	0.52	0.59	0.57	0.64	0.63	0.70	0.68
9½	0.38	0.37	0.43	0.41	0.48	0.46	0.53	0.51	0.58	0.56	0.63	0.61	0.69	0.66
9¾	0.38	0.36	0.43	0.40	0.48	0.45	0.52	0.49	0.57	0.54	0.62	0.59	0.67	0.63
10	0.38	0.35	0.43	0.40	0.47	0.44	0.52	0.48	0.57	0.52	0.61	0.57	0.66	0.61
10¼	0.38	0.35	0.43	0.39	0.47	0.43	0.52	0.47	0.56	0.51	0.61	0.55	0.65	0.59
10½	0.38	0.34	0.43	0.38	0.47	0.42	0.51	0.45	0.56	0.49	0.60	0.53	0.65	0.57
10¾	0.39	0.33	0.43	0.37	0.47	0.40	0.51	0.44	0.56	0.48	0.60	0.51	0.64	0.55
11	0.39	0.32	0.43	0.36	0.47	0.39	0.51	0.43	0.56	0.46	0.60	0.50	0.64	0.53
11¼	0.39	0.31	0.44	0.35	0.48	0.38	0.52	0.41	0.56	0.45	0.60	0.48	0.64	0.51
11½	0.40	0.31	0.44	0.34	0.48	0.37	0.52	0.40	0.56	0.43	0.60	0.46	0.63	0.49
11¾	0.41	0.30	0.45	0.33	0.49	0.36	0.52	0.39	0.56	0.42	0.60	0.44	0.64	0.47
12	0.41	0.29	0.45	0.32	0.49	0.35	0.53	0.37	0.57	0.40	0.60	0.43	0.64	0.45
12¼	0.42	0.28	0.46	0.31	0.50	0.34	0.54	0.36	0.57	0.38	0.61	0.41	0.64	0.42
12½	0.43	0.28	0.47	0.30	0.51	0.32	0.55	0.35	0.58	0.37	0.61	0.39	0.65	0.41
12¾	0.45	0.27	0.48	0.29	0.52	0.31	0.56	0.33	0.59	0.35	0.62	0.37	0.65	0.39
13	0.46	0.26	0.50	0.28	0.53	0.30	0.57	0.32	0.60	0.33	0.63	0.35	0.66	0.37
13¼	0.48	0.24	0.51	0.26	0.55	0.28	0.58	0.30	0.61	0.32	0.64	0.33	0.67	0.35
13½	0.50	0.23	0.53	0.25	0.57	0.27	0.60	0.28	0.63	0.30	0.66	0.31	0.69	0.32
13¾	0.52	0.22	0.55	0.24	0.59	0.25	0.62	0.26	0.65	0.28	0.68	0.29	0.70	0.30
14	0.54	0.21	0.58	0.22	0.61	0.23	0.64	0.24	0.67	0.26	0.69	0.27	0.72	0.28

TABLE 5A.

Distance of an Object by Two Bearings.

Difference between the course and second bearing, in points.	Difference between the course and first bearing, in points.													
	3¾		4		4¼		4½		4¾		5		5¼	
4¾	3.44	2.76												
5	2.76	2.30	3.62	3.01										
5¼	2.31	1.98	2.91	2.50	3.80	3.26								
5½	1.99	1.76	2.44	2.15	3.05	2.69	3.96	3.49						
5¾	1.75	1.59	2.10	1.90	2.55	2.31	3.18	2.88	4.12	3.72				
6	1.57	1.45	1.85	1.71	2.20	2.03	2.66	2.46	3.31	3.05	4.26	3.94		
6¼	1.42	1.34	1.65	1.56	1.94	1.82	2.29	2.16	2.77	2.61	3.42	3.22	4.40	4.14
6½	1.31	1.25	1.50	1.44	1.73	1.66	2.02	1.93	2.38	2.28	2.86	2.74	3.53	3.38
6¾	1.21	1.17	1.38	1.33	1.57	1.52	1.81	1.75	2.10	2.04	2.47	2.39	2.95	2.87
7	1.13	1.11	1.27	1.25	1.44	1.41	1.64	1.61	1.88	1.84	2.17	2.13	2.55	2.50
7¼	1.06	1.05	1.19	1.17	1.33	1.32	1.50	1.49	1.70	1.69	1.94	1.92	2.24	2.22
7½	1.00	1.00	1.11	1.11	1.24	1.24	1.39	1.38	1.56	1.55	1.76	1.76	2.01	2.00
7¾	0.95	0.95	1.05	1.05	1.17	1.17	1.30	1.30	1.45	1.44	1.62	1.62	1.82	1.82
8	0.91	0.91	1.00	1.00	1.10	1.10	1.22	1.22	1.35	1.35	1.50	1.50	1.67	1.67
8¼	0.87	0.87	0.95	0.95	1.05	1.05	1.15	1.15	1.27	1.26	1.40	1.39	1.54	1.54
8½	0.84	0.83	0.91	0.91	1.00	1.00	1.09	1.09	1.20	1.19	1.31	1.30	1.44	1.43
8¾	0.81	0.80	0.88	0.87	0.96	0.95	1.04	1.03	1.14	1.12	1.24	1.22	1.35	1.34
9	0.78	0.77	0.85	0.83	0.92	0.90	1.00	0.98	1.08	1.06	1.18	1.15	1.28	1.25
9¼	0.76	0.74	0.82	0.80	0.89	0.86	0.96	0.93	1.04	1.01	1.12	1.09	1.21	1.18
9½	0.74	0.71	0.80	0.77	0.86	0.83	0.93	0.89	1.00	0.96	1.08	1.03	1.16	1.11
9¾	0.73	0.68	0.78	0.74	0.84	0.79	0.90	0.85	0.97	0.91	1.04	0.97	1.11	1.04
10	0.71	0.66	0.77	0.71	0.82	0.76	0.88	0.81	0.94	0.87	1.00	0.92	1.07	0.99
10¼	0.70	0.63	0.75	0.68	0.80	0.72	0.86	0.77	0.91	0.82	0.97	0.88	1.03	0.93
10½	0.69	0.61	0.74	0.65	0.79	0.69	0.84	0.74	0.89	0.78	0.94	0.83	1.00	0.88
10¾	0.68	0.59	0.73	0.63	0.77	0.66	0.82	0.70	0.87	0.75	0.92	0.79	0.97	0.83
11	0.68	0.56	0.72	0.60	0.76	0.64	0.81	0.67	0.85	0.71	0.90	0.75	0.95	0.79
11¼	0.67	0.54	0.71	0.57	0.76	0.61	0.80	0.64	0.84	0.67	0.88	0.71	0.93	0.75
11½	0.67	0.52	0.71	0.55	0.75	0.58	0.79	0.61	0.83	0.64	0.87	0.67	0.91	0.70
11¾	0.67	0.50	0.71	0.52	0.74	0.55	0.78	0.58	0.82	0.61	0.86	0.64	0.90	0.66
12	0.67	0.48	0.71	0.50	0.74	0.52	0.78	0.55	0.81	0.57	0.85	0.60	0.88	0.63
12¼	0.67	0.45	0.71	0.48	0.74	0.50	0.77	0.52	0.81	0.54	0.84	0.56	0.87	0.59
12½	0.68	0.43	0.71	0.45	0.74	0.47	0.77	0.49	0.80	0.51	0.84	0.53	0.87	0.55
12¾	0.68	0.41	0.71	0.43	0.74	0.44	0.77	0.46	0.80	0.48	0.83	0.50	0.86	0.51
13	0.69	0.38	0.72	0.40	0.75	0.42	0.78	0.43	0.80	0.45	0.83	0.46	0.86	0.48
13¼	0.70	0.36	0.73	0.37	0.76	0.39	0.78	0.40	0.81	0.41	0.83	0.43	0.86	0.44
13½	0.71	0.34	0.74	0.35	0.76	0.36	0.79	0.37	0.81	0.38	0.84	0.39	0.86	0.41
13¾	0.73	0.31	0.75	0.32	0.77	0.33	0.80	0.34	0.82	0.35	0.84	0.36	0.86	0.37
14	0.74	0.28	0.77	0.29	0.79	0.30	0.81	0.31	0.83	0.32	0.85	0.32	0.87	0.33

	5½		5¾		6		6¼		6½		6¾		7	
6¼	4.52	4.33												
6½	3.63	3.52	4.63	4.49										
7	3.04	2.98	3.72	3.65	4.74	4.64								
7¼	2.62	2.59	3.11	3.08	3.80	3.76	4.83	4.77						
7½	2.30	2.29	2.68	2.67	3.18	3.17	3.87	3.86	4.91	4.88				
7¾	2.06	2.06	2.36	2.36	2.74	2.74	3.24	3.24	3.94	3.93	4.97	4.97		
8	1.87	1.87	2.11	2.11	2.41	2.41	2.79	2.79	3.30	3.30	3.99	3.99	5.03	5.03
8¼	1.72	1.71	1.92	1.92	2.16	2.16	2.46	2.46	2.84	2.84	3.34	3.34	4.04	4.03
8½	1.59	1.58	1.76	1.75	1.96	1.95	2.20	2.19	2.50	2.49	2.88	2.87	3.38	3.36
8¾	1.48	1.46	1.63	1.61	1.80	1.78	2.00	1.98	2.24	2.21	2.53	2.51	2.91	2.88
9	1.39	1.36	1.52	1.49	1.66	1.63	1.83	1.80	2.03	1.99	2.27	2.23	2.56	2.51
9¼	1.31	1.27	1.42	1.38	1.55	1.50	1.69	1.64	1.86	1.81	2.06	2.00	2.29	2.23
9½	1.25	1.19	1.35	1.29	1.46	1.39	1.58	1.51	1.72	1.65	1.89	1.81	2.08	1.99
9¾	1.19	1.12	1.28	1.20	1.38	1.30	1.48	1.40	1.61	1.51	1.75	1.64	1.91	1.80
10	1.14	1.05	1.22	1.13	1.31	1.21	1.40	1.30	1.51	1.39	1.62	1.50	1.77	1.63
10¼	1.10	0.99	1.17	1.06	1.25	1.13	1.33	1.20	1.42	1.29	1.53	1.38	1.65	1.49
10½	1.06	0.94	1.13	0.99	1.20	1.05	1.27	1.12	1.35	1.19	1.44	1.27	1.55	1.36
10¾	1.03	0.88	1.09	0.93	1.15	0.99	1.22	1.04	1.29	1.11	1.37	1.18	1.46	1.25
11	1.00	0.83	1.05	0.88	1.11	0.92	1.17	0.97	1.24	1.03	1.31	1.09	1.39	1.15
11¼	0.98	0.78	1.03	0.82	1.08	0.87	1.13	0.91	1.19	0.96	1.25	1.01	1.32	1.06
11½	0.95	0.73	1.00	0.77	1.05	0.81	1.10	0.85	1.15	0.89	1.21	0.93	1.27	0.98
11¾	0.94	0.69	0.98	0.72	1.02	0.76	1.07	0.79	1.12	0.83	1.17	0.86	1.22	0.90
12	0.92	0.65	0.96	0.68	1.00	0.71	1.04	0.73	1.09	0.77	1.13	0.80	1.18	0.83
12¼	0.91	0.61	0.94	0.63	0.98	0.66	1.02	0.68	1.06	0.71	1.10	0.74	1.14	0.77
12½	0.90	0.57	0.93	0.59	0.97	0.61	1.00	0.63	1.04	0.66	1.07	0.68	1.11	0.71
12¾	0.89	0.53	0.92	0.55	0.95	0.57	0.98	0.59	1.02	0.61	1.05	0.63	1.08	0.65
13	0.89	0.49	0.91	0.51	0.94	0.52	0.97	0.54	1.00	0.56	1.03	0.57	1.06	0.59
13¼	0.88	0.45	0.91	0.47	0.93	0.48	0.96	0.49	0.99	0.51	1.01	0.52	1.04	0.54
13½	0.88	0.42	0.91	0.43	0.93	0.44	0.95	0.45	0.98	0.46	1.00	0.47	1.02	0.48
13¾	0.88	0.38	0.90	0.39	0.92	0.40	0.95	0.41	0.97	0.41	0.99	0.42	1.01	0.43
14	0.89	0.34	0.91	0.35	0.92	0.35	0.94	0.36	0.90	0.37	0.98	0.38	1.00	0.38

TABLE 5A.

Distance of an Object by Two Bearings.

Difference between the course and second bearing, in points.	Difference between the course and first bearing, in points.															
	7¼		7½		7¾		8		8¼		8½		8¾		9	
8¼	5.07	5.06														
8½	4.07	4.05	5.10	5.08												
8¾	3.41	3.37	4.10	4.06	5.12	5.06										
9	2.94	2.88	3.43	3.36	4.11	4.03	5.13	5.03								
9¼	2.58	2.51	2.95	2.87	3.44	3.34	4.12	3.39	5.12	4.97						
9½	2.31	2.21	2.60	2.49	2.96	2.84	3.44	3.30	4.11	3.93	5.10	4.88				
9¾	2.10	1.98	2.33	2.19	2.61	2.46	2.97	2.79	3.44	3.24	4.10	3.86	5.07	4.77		
10	1.92	1.78	2.11	1.95	2.34	2.16	2.61	2.41	2.96	2.74	3.43	3.17	4.07	3.76	5.03	4.64
10¼	1.78	1.61	1.93	1.75	2.12	1.92	2.34	2.11	2.61	2.36	2.95	2.67	3.41	3.08	4.04	3.65
10½	1.66	1.46	1.79	1.58	1.94	1.71	2.12	1.87	2.34	2.06	2.60	2.29	2.94	2.59	3.38	2.98
10¾	1.56	1.34	1.67	1.43	1.80	1.54	1.95	1.67	2.12	1.82	2.33	2.00	2.58	2.22	2.91	2.50
11	1.47	1.22	1.57	1.30	1.68	1.39	1.80	1.50	1.94	1.62	2.11	1.76	2.31	1.92	2.56	2.13
11¼	1.40	1.12	1.48	1.19	1.57	1.26	1.68	1.35	1.80	1.44	1.93	1.55	2.10	1.69	2.29	1.84
11½	1.34	1.03	1.41	1.09	1.49	1.15	1.58	1.22	1.68	1.30	1.79	1.38	1.92	1.49	2.08	1.61
11¾	1.28	0.95	1.34	1.00	1.41	1.05	1.49	1.10	1.57	1.17	1.67	1.24	1.78	1.32	1.91	1.41
12	1.23	0.87	1.29	0.91	1.35	0.95	1.41	1.00	1.49	1.05	1.57	1.11	1.66	1.17	1.77	1.25
12¼	1.19	0.80	1.24	0.83	1.29	0.87	1.35	0.91	1.41	0.95	1.48	1.00	1.56	1.05	1.65	1.11
12½	1.15	0.73	1.20	0.76	1.24	0.79	1.29	0.82	1.35	0.86	1.41	0.89	1.47	0.93	1.55	0.98
12¾	1.12	0.67	1.16	0.69	1.20	0.72	1.25	0.74	1.29	0.77	1.34	0.80	1.40	0.83	1.46	0.87
13	1.09	0.61	1.13	0.63	1.16	0.65	1.20	0.67	1.24	0.69	1.29	0.72	1.34	0.74	1.39	0.77
13¼	1.07	0.55	1.10	0.57	1.13	0.58	1.17	0.60	1.20	0.62	1.24	0.64	1.28	0.66	1.32	0.68
13½	1.05	0.50	1.08	0.51	1.10	0.52	1.13	0.53	1.16	0.55	1.20	0.56	1.23	0.58	1.27	0.60
13¾	1.03	0.44	1.06	0.45	1.08	0.46	1.11	0.47	1.13	0.48	1.16	0.50	1.19	0.51	1.22	0.52
14	1.02	0.39	1.04	0.40	1.06	0.41	1.08	0.41	1.10	0.42	1.13	0.43	1.15	0.44	1.18	0.45

	9¼		9½		9¾		10		10¼		10½		10¾		11	
10¼	4.97	4.50														
10½	3.99	3.52	4.91	4.33												
10¾	3.34	2.87	3.94	3.38	4.83	4.14										
11	2.88	2.39	3.30	2.74	3.87	3.22	4.74	3.94								
11¼	2.53	2.04	2.84	2.28	3.24	2.61	3.80	3.05	4.63	3.72						
11½	2.27	1.75	2.50	1.93	2.79	2.16	3.18	2.46	3.72	2.88	4.52	3.49				
11¾	2.06	1.52	2.24	1.66	2.46	1.82	2.74	2.03	3.11	2.31	3.63	2.69	4.40	3.20		
12	1.89	1.33	2.03	1.44	2.20	1.56	2.41	1.71	2.68	1.90	3.04	2.15	3.53	2.50	4.26	3.01
12¼	1.75	1.18	1.86	1.25	2.00	1.34	2.16	1.45	2.36	1.59	2.62	1.76	2.95	1.98	3.42	2.30
12½	1.62	1.03	1.72	1.09	1.83	1.16	1.96	1.24	2.11	1.34	2.30	1.46	2.55	1.62	2.86	1.82
12¾	1.53	0.91	1.61	0.96	1.69	1.01	1.80	1.07	1.92	1.14	2.06	1.23	2.24	1.34	2.47	1.47
13	1.44	0.80	1.51	0.84	1.58	0.88	1.66	0.92	1.76	0.98	1.87	1.04	2.01	1.11	2.17	1.21
13¼	1.37	0.71	1.42	0.73	1.48	0.76	1.55	0.80	1.63	0.84	1.72	0.88	1.82	0.94	1.94	1.00
13½	1.31	0.62	1.35	0.64	1.40	0.66	1.46	0.69	1.52	0.72	1.59	0.75	1.67	0.79	1.76	0.83
13¾	1.25	0.54	1.29	0.55	1.33	0.57	1.38	0.59	1.42	0.61	1.48	0.63	1.54	0.66	1.62	0.69
14	1.21	0.46	1.24	0.47	1.27	0.49	1.31	0.50	1.35	0.52	1.39	0.53	1.44	0.55	1.50	0.57

	11¼		11½		11¾		12		12¼		12½		12¾		13	
12¼	4.12	2.77														
12½	3.31	2.10	3.96	2.51												
12¾	2.77	1.65	3.18	1.90	3.80	2.26										
13	2.38	1.32	2.66	1.48	3.05	1.69	3.62	2.01								
13¼	2.10	1.08	2.29	1.18	2.55	1.31	2.91	1.50	3.44	1.77						
13½	1.88	0.89	2.02	0.95	2.20	1.04	2.44	1.15	2.76	1.30	3.25	1.53				
13¾	1.70	0.73	1.81	0.77	1.94	0.83	2.10	0.90	2.31	0.99	2.61	1.12	3.05	1.31		
14	1.56	0.60	1.64	0.63	1.73	0.66	1.85	0.71	1.99	0.76	2.19	0.84	2.45	0.94	2.85	1.09

TABLE 5B.

Distance of an Object by Two Bearings.

Difference between the course and second bearing.	Difference between the course and first bearing.													
	20°		22°		24°		26°		28°		30°		32°	
30°	1.97	0.98												
32	1.64	0.87	2.16	1.14										
34	1.41	0.79	1.80	1.01	2.34	1.31								
36	1.24	0.73	1.55	0.91	1.96	1.15	2.52	1.48						
38	1.11	0.68	1.36	0.84	1.68	1.04	2.11	1.30	2.70	1.66				
40	1.00	0.64	1.21	0.78	1.48	0.95	1.81	1.16	2.26	1.45	2.88	1.85		
42	0.91	0.61	1.10	0.73	1.32	0.88	1.59	1.06	1.94	1.30	2.40	1.61	3.05	2.04
44	0.84	0.58	1.00	0.69	1.19	0.83	1.42	0.98	1.70	1.18	2.07	1.44	2.55	1.77
46	0.78	0.56	0.92	0.66	1.09	0.78	1.28	0.92	1.52	1.09	1.81	1.30	2.19	1.58
48	0.73	0.54	0.85	0.64	1.00	0.74	1.17	0.87	1.37	1.02	1.62	1.20	1.92	1.43
50	0.68	0.52	0.80	0.61	0.93	0.71	1.08	0.83	1.25	0.96	1.46	1.12	1.71	1.31
52	0.65	0.51	0.75	0.59	0.87	0.68	1.00	0.79	1.15	0.91	1.33	1.05	1.55	1.22
54	0.61	0.49	0.71	0.57	0.81	0.66	0.93	0.76	1.07	0.87	1.23	0.99	1.41	1.14
56	0.58	0.48	0.67	0.56	0.77	0.64	0.88	0.73	1.00	0.83	1.14	0.95	1.30	1.08
58	0.56	0.47	0.64	0.54	0.73	0.62	0.83	0.70	0.94	0.80	1.07	0.90	1.21	1.03
60	0.53	0.46	0.61	0.53	0.69	0.60	0.78	0.68	0.89	0.77	1.00	0.87	1.13	0.98
62	0.51	0.45	0.58	0.51	0.66	0.58	0.75	0.66	0.84	0.74	0.94	0.83	1.06	0.94
64	0.49	0.44	0.56	0.50	0.63	0.57	0.71	0.64	0.80	0.72	0.89	0.80	1.00	0.90
66	0.48	0.43	0.54	0.49	0.61	0.56	0.68	0.62	0.76	0.70	0.85	0.78	0.95	0.87
68	0.46	0.43	0.52	0.48	0.59	0.54	0.66	0.61	0.73	0.68	0.81	0.75	0.90	0.84
70	0.45	0.42	0.50	0.47	0.57	0.53	0.63	0.59	0.70	0.66	0.78	0.73	0.86	0.81
72	0.43	0.41	0.49	0.47	0.55	0.52	0.61	0.58	0.68	0.64	0.75	0.71	0.82	0.78
74	0.42	0.41	0.48	0.46	0.53	0.51	0.59	0.57	0.65	0.63	0.72	0.69	0.79	0.76
76	0.41	0.40	0.46	0.45	0.52	0.50	0.57	0.56	0.63	0.61	0.70	0.67	0.76	0.74
78	0.40	0.39	0.45	0.44	0.50	0.49	0.56	0.54	0.61	0.60	0.67	0.66	0.74	0.72
80	0.39	0.39	0.44	0.44	0.49	0.48	0.54	0.53	0.60	0.59	0.65	0.64	0.71	0.70
82	0.39	0.38	0.43	0.43	0.48	0.47	0.53	0.52	0.58	0.57	0.63	0.63	0.69	0.69
84	0.38	0.38	0.42	0.42	0.47	0.47	0.52	0.51	0.57	0.56	0.62	0.61	0.67	0.67
86	0.37	0.37	0.42	0.42	0.46	0.46	0.51	0.51	0.55	0.55	0.60	0.60	0.66	0.65
88	0.37	0.37	0.41	0.41	0.45	0.45	0.50	0.50	0.54	0.54	0.59	0.59	0.64	0.64
90	0.36	0.36	0.40	0.40	0.45	0.45	0.49	0.49	0.53	0.53	0.58	0.58	0.62	0.62
92	0.36	0.36	0.40	0.40	0.44	0.44	0.48	0.48	0.52	0.52	0.57	0.57	0.61	0.61
94	0.36	0.35	0.39	0.39	0.43	0.43	0.47	0.47	0.51	0.51	0.56	0.55	0.60	0.60
96	0.35	0.35	0.39	0.39	0.43	0.43	0.47	0.46	0.51	0.50	0.55	0.54	0.59	0.59
98	0.35	0.35	0.39	0.38	0.42	0.42	0.46	0.46	0.50	0.50	0.54	0.53	0.58	0.57
100	0.35	0.34	0.38	0.38	0.42	0.41	0.46	0.45	0.49	0.49	0.53	0.52	0.57	0.56
102	0.35	0.34	0.38	0.37	0.42	0.41	0.45	0.44	0.49	0.48	0.53	0.51	0.56	0.55
104	0.34	0.33	0.38	0.37	0.41	0.40	0.45	0.43	0.48	0.47	0.52	0.50	0.56	0.54
106	0.34	0.33	0.38	0.36	0.41	0.39	0.45	0.43	0.48	0.46	0.52	0.50	0.55	0.53
108	0.34	0.32	0.38	0.36	0.41	0.39	0.44	0.42	0.48	0.45	0.51	0.49	0.55	0.52
110	0.34	0.32	0.37	0.35	0.41	0.38	0.44	0.41	0.47	0.44	0.51	0.48	0.54	0.51
112	0.34	0.32	0.37	0.35	0.41	0.38	0.44	0.41	0.47	0.44	0.50	0.47	0.54	0.50
114	0.34	0.31	0.37	0.34	0.41	0.37	0.44	0.40	0.47	0.43	0.50	0.46	0.54	0.49
116	0.34	0.31	0.38	0.34	0.41	0.37	0.44	0.39	0.47	0.42	0.50	0.45	0.53	0.48
118	0.35	0.31	0.38	0.33	0.41	0.36	0.44	0.39	0.47	0.41	0.50	0.44	0.53	0.47
120	0.35	0.30	0.38	0.33	0.41	0.36	0.44	0.38	0.47	0.41	0.50	0.43	0.53	0.46
122	0.35	0.30	0.38	0.32	0.41	0.35	0.44	0.37	0.47	0.40	0.50	0.42	0.53	0.45
124	0.35	0.29	0.38	0.32	0.41	0.34	0.44	0.37	0.47	0.39	0.50	0.42	0.53	0.44
126	0.36	0.29	0.39	0.31	0.42	0.34	0.45	0.36	0.47	0.38	0.50	0.41	0.53	0.43
128	0.36	0.28	0.39	0.31	0.42	0.33	0.45	0.35	0.48	0.38	0.50	0.40	0.53	0.42
130	0.36	0.28	0.39	0.30	0.42	0.32	0.45	0.35	0.48	0.37	0.51	0.39	0.54	0.41
132	0.37	0.27	0.40	0.30	0.43	0.32	0.46	0.34	0.48	0.36	0.51	0.38	0.54	0.40
134	0.37	0.27	0.40	0.29	0.43	0.31	0.46	0.33	0.49	0.35	0.52	0.37	0.54	0.39
136	0.38	0.26	0.41	0.28	0.44	0.30	0.47	0.32	0.49	0.34	0.52	0.36	0.55	0.38
138	0.39	0.26	0.42	0.28	0.45	0.30	0.47	0.32	0.50	0.33	0.53	0.35	0.55	0.37
140	0.39	0.25	0.42	0.27	0.45	0.29	0.48	0.31	0.51	0.33	0.53	0.34	0.56	0.36
142	0.40	0.25	0.43	0.27	0.46	0.28	0.49	0.30	0.51	0.32	0.54	0.33	0.56	0.35
144	0.41	0.24	0.44	0.26	0.47	0.28	0.50	0.29	0.52	0.31	0.55	0.32	0.57	0.34
146	0.42	0.24	0.45	0.25	0.48	0.27	0.51	0.28	0.53	0.30	0.56	0.31	0.58	0.32
148	0.43	0.23	0.46	0.25	0.49	0.26	0.52	0.27	0.54	0.29	0.57	0.30	0.59	0.31
150	0.45	0.22	0.48	0.24	0.50	0.25	0.53	0.26	0.55	0.28	0.58	0.29	0.60	0.30
152	0.46	0.22	0.49	0.23	0.52	0.24	0.54	0.25	0.57	0.27	0.59	0.28	0.61	0.29
154	0.48	0.21	0.50	0.22	0.53	0.23	0.56	0.24	0.58	0.25	0.60	0.26	0.62	0.27
156	0.49	0.20	0.52	0.21	0.55	0.22	0.57	0.23	0.60	0.24	0.62	0.25	0.64	0.26
158	0.51	0.19	0.54	0.20	0.57	0.21	0.59	0.22	0.61	0.23	0.63	0.24	0.66	0.25
160	0.53	0.18	0.56	0.19	0.59	0.20	0.61	0.21	0.63	0.22	0.65	0.22	0.67	0.23

TABLE 5B.

Distance of an Object by Two Bearings.

Difference between the course and second bearing.	Difference between the course and first bearing.													
	34°		36°		38°		40°		42°		44°		46°	
44°	3.22	2.24												
46	2.69	1.93	3.39	2.43										
48	2.31	1.72	2.83	2.10	3.55	2.63								
50	2.03	1.55	2.43	1.86	2.96	2.27	3.70	2.84						
52	1.81	1.43	2.13	1.68	2.54	2.01	3.09	2.44	3.85	3.04				
54	1.63	1.32	1.90	1.54	2.23	1.81	2.66	2.15	3.22	2.60	4.00	3.24		
56	1.49	1.24	1.72	1.42	1.99	1.65	2.33	1.93	2.77	2.29	3.34	2.77	4.14	3.43
58	1.37	1.17	1.57	1.33	1.80	1.53	2.08	1.76	2.43	2.06	2.87	2.44	3.46	2.93
60	1.28	1.10	1.45	1.25	1.64	1.42	1.88	1.63	2.17	1.88	2.52	2.18	2.97	2.57
62	1.19	1.05	1.34	1.18	1.51	1.34	1.72	1.52	1.96	1.73	2.25	1.98	2.61	2.30
64	1.12	1.01	1.25	1.13	1.40	1.26	1.58	1.42	1.79	1.61	2.03	1.83	2.33	2.09
66	1.06	0.96	1.18	1.07	1.31	1.20	1.47	1.34	1.65	1.51	1.85	1.69	2.10	1.92
68	1.00	0.93	1.11	1.03	1.23	1.14	1.37	1.27	1.53	1.42	1.71	1.58	1.92	1.78
70	0.95	0.89	1.05	0.99	1.16	1.09	1.29	1.21	1.43	1.34	1.58	1.49	1.77	1.66
72	0.91	0.86	1.00	0.95	1.10	1.05	1.21	1.15	1.34	1.27	1.48	1.41	1.64	1.56
74	0.87	0.84	0.95	0.92	1.05	1.01	1.15	1.10	1.26	1.21	1.39	1.34	1.53	1.47
76	0.84	0.81	0.91	0.89	1.00	0.97	1.09	1.06	1.20	1.16	1.31	1.27	1.44	1.40
78	0.80	0.79	0.88	0.86	0.96	0.94	1.04	1.02	1.14	1.11	1.24	1.22	1.36	1.33
80	0.78	0.77	0.85	0.83	0.92	0.91	1.00	0.98	1.09	1.07	1.18	1.16	1.28	1.27
82	0.75	0.75	0.82	0.81	0.89	0.88	0.96	0.95	1.04	1.03	1.13	1.12	1.22	1.21
84	0.73	0.73	0.79	0.79	0.86	0.85	0.93	0.92	1.00	0.99	1.08	1.07	1.17	1.16
86	0.71	0.71	0.77	0.77	0.83	0.83	0.89	0.89	0.96	0.96	1.04	1.04	1.12	1.12
88	0.69	0.69	0.75	0.75	0.80	0.80	0.86	0.86	0.93	0.93	1.00	1.00	1.08	1.07
90	0.67	0.67	0.73	0.73	0.78	0.78	0.84	0.84	0.90	0.90	0.97	0.97	1.04	1.04
92	0.66	0.66	0.71	0.71	0.76	0.76	0.82	0.82	0.87	0.87	0.93	0.93	1.00	1.00
94	0.65	0.64	0.69	0.69	0.74	0.74	0.79	0.79	0.85	0.85	0.91	0.90	0.97	0.97
96	0.63	0.63	0.68	0.67	0.73	0.72	0.78	0.77	0.83	0.82	0.88	0.88	0.94	0.93
98	0.62	0.62	0.67	0.66	0.71	0.70	0.76	0.75	0.81	0.80	0.86	0.85	0.91	0.90
100	0.61	0.60	0.65	0.64	0.70	0.69	0.74	0.73	0.79	0.78	0.84	0.83	0.89	0.88
102	0.60	0.59	0.64	0.63	0.68	0.67	0.73	0.71	0.77	0.76	0.82	0.80	0.87	0.85
104	0.60	0.58	0.63	0.61	0.67	0.65	0.72	0.69	0.76	0.74	0.80	0.78	0.85	0.82
106	0.59	0.57	0.63	0.60	0.66	0.64	0.70	0.68	0.74	0.72	0.79	0.76	0.83	0.80
108	0.58	0.55	0.62	0.59	0.66	0.62	0.69	0.66	0.73	0.70	0.77	0.74	0.81	0.77
110	0.58	0.54	0.61	0.57	0.65	0.61	0.68	0.64	0.72	0.68	0.76	0.71	0.80	0.75
112	0.57	0.53	0.61	0.56	0.64	0.59	0.68	0.63	0.71	0.66	0.75	0.69	0.79	0.73
114	0.57	0.52	0.60	0.55	0.63	0.58	0.67	0.61	0.70	0.64	0.74	0.68	0.78	0.71
116	0.56	0.51	0.60	0.54	0.63	0.57	0.66	0.60	0.70	0.63	0.73	0.66	0.77	0.69
118	0.56	0.50	0.59	0.52	0.63	0.55	0.66	0.58	0.69	0.61	0.72	0.64	0.76	0.67
120	0.56	0.49	0.59	0.51	0.62	0.54	0.65	0.57	0.68	0.59	0.72	0.62	0.75	0.65
122	0.56	0.47	0.59	0.50	0.62	0.53	0.65	0.55	0.68	0.58	0.71	0.60	0.74	0.63
124	0.56	0.46	0.59	0.49	0.62	0.51	0.65	0.54	0.68	0.56	0.71	0.58	0.74	0.61
126	0.56	0.45	0.59	0.48	0.62	0.50	0.64	0.52	0.67	0.54	0.70	0.57	0.73	0.59
128	0.56	0.44	0.59	0.46	0.62	0.49	0.64	0.51	0.67	0.53	0.70	0.55	0.73	0.57
130	0.56	0.43	0.59	0.45	0.62	0.47	0.64	0.49	0.67	0.51	0.70	0.53	0.72	0.55
132	0.56	0.42	0.59	0.44	0.62	0.46	0.64	0.48	0.67	0.50	0.70	0.52	0.72	0.54
134	0.57	0.41	0.59	0.43	0.62	0.45	0.64	0.46	0.67	0.48	0.69	0.50	0.72	0.52
136	0.57	0.40	0.60	0.41	0.62	0.43	0.65	0.45	0.67	0.47	0.70	0.48	0.72	0.50
138	0.58	0.39	0.60	0.40	0.63	0.42	0.65	0.43	0.67	0.45	0.70	0.47	0.72	0.48
140	0.58	0.37	0.61	0.39	0.63	0.40	0.65	0.42	0.68	0.43	0.70	0.45	0.72	0.46
142	0.59	0.36	0.61	0.38	0.63	0.39	0.66	0.41	0.68	0.42	0.70	0.43	0.72	0.45
144	0.60	0.35	0.62	0.36	0.64	0.38	0.66	0.39	0.68	0.40	0.71	0.41	0.73	0.43
146	0.60	0.34	0.63	0.35	0.65	0.36	0.67	0.37	0.69	0.39	0.71	0.40	0.73	0.41
148	0.61	0.32	0.63	0.34	0.66	0.35	0.68	0.36	0.70	0.37	0.72	0.38	0.74	0.39
150	0.62	0.31	0.64	0.32	0.66	0.33	0.68	0.34	0.70	0.35	0.72	0.36	0.74	0.37
152	0.63	0.30	0.65	0.31	0.67	0.32	0.69	0.33	0.71	0.33	0.73	0.34	0.75	0.35
154	0.65	0.28	0.67	0.29	0.68	0.30	0.70	0.31	0.72	0.32	0.74	0.32	0.76	0.33
156	0.66	0.27	0.68	0.28	0.70	0.28	0.72	0.29	0.73	0.30	0.75	0.30	0.77	0.31
158	0.67	0.25	0.69	0.26	0.71	0.27	0.73	0.27	0.74	0.28	0.76	0.28	0.78	0.29
160	0.69	0.24	0.71	0.24	0.73	0.25	0.74	0.25	0.76	0.26	0.77	0.26	0.79	0.27

TABLE 5B.

Distance of an Object by Two Bearings.

Difference between the course and second bearing.	Difference between the course and first bearing.													
	48°		50°		52°		54°		56°		58°		60°	
58°	4.28	3.63												
60	3.57	3.10	4.41	3.82										
62	3.07	2.71	3.68	3.25	4.54	4.01								
64	2.70	2.42	3.17	2.85	3.79	3.41	4.66	4.19						
66	2.40	2.20	2.78	2.54	3.26	2.98	3.89	3.55	4.77	4.36				
68	2.17	2.01	2.48	2.30	2.86	2.65	3.34	3.10	3.99	3.71	4.88	4.53		
70	1.98	1.86	2.24	2.10	2.55	2.39	2.94	2.76	3.43	3.22	4.08	3.83	4.99	4.69
72	1.83	1.74	2.04	1.94	2.30	2.19	2.62	2.49	3.01	2.86	3.51	3.33	4.17	3.98
74	1.70	1.63	1.88	1.81	2.10	2.02	2.37	2.27	2.68	2.58	3.08	2.96	3.58	3.44
76	1.58	1.54	1.75	1.70	1.94	1.88	2.16	2.10	2.42	2.35	2.74	2.66	3.14	3.05
78	1.49	1.45	1.63	1.60	1.80	1.76	1.99	1.95	2.21	2.16	2.48	2.43	2.80	2.74
80	1.40	1.38	1.53	1.51	1.68	1.65	1.85	1.82	2.04	2.01	2.26	2.23	2.53	2.49
82	1.33	1.32	1.45	1.43	1.58	1.56	1.72	1.71	1.89	1.87	2.08	2.06	2.31	2.29
84	1.26	1.26	1.37	1.36	1.49	1.48	1.62	1.61	1.77	1.76	1.93	1.92	2.13	2.12
86	1.21	1.20	1.30	1.30	1.41	1.41	1.53	1.52	1.66	1.65	1.81	1.80	1.98	1.97
88	1.16	1.16	1.24	1.24	1.34	1.34	1.45	1.45	1.56	1.56	1.70	1.70	1.84	1.84
90	1.11	1.11	1.19	1.19	1.28	1.28	1.38	1.38	1.48	1.48	1.60	1.60	1.73	1.73
92	1.07	1.07	1.14	1.14	1.23	1.23	1.31	1.31	1.41	1.41	1.52	1.52	1.63	1.63
94	1.03	1.03	1.10	1.10	1.18	1.17	1.26	1.26	1.35	1.34	1.44	1.44	1.55	1.54
96	1.00	0.99	1.06	1.06	1.13	1.13	1.21	1.20	1.29	1.28	1.38	1.37	1.47	1.47
98	0.97	0.96	1.03	1.02	1.10	1.08	1.16	1.15	1.24	1.23	1.32	1.31	1.41	1.39
100	0.94	0.93	1.00	0.98	1.06	1.04	1.12	1.11	1.19	1.18	1.27	1.25	1.35	1.33
102	0.92	0.90	0.97	0.95	1.03	1.01	1.09	1.06	1.15	1.13	1.22	1.19	1.29	1.27
104	0.90	0.87	0.95	0.92	1.00	0.97	1.06	1.02	1.12	1.08	1.18	1.14	1.25	1.21
106	0.88	0.84	0.92	0.89	0.97	0.94	1.03	0.99	1.09	1.04	1.14	1.10	1.20	1.16
108	0.86	0.82	0.90	0.86	0.95	0.90	1.00	0.95	1.05	1.00	1.11	1.05	1.17	1.11
110	0.84	0.79	0.88	0.83	0.93	0.87	0.98	0.92	1.02	0.96	1.08	1.01	1.13	1.06
112	0.83	0.77	0.87	0.80	0.91	0.84	0.95	0.88	1.00	0.93	1.05	0.97	1.10	1.02
114	0.81	0.74	0.85	0.78	0.89	0.82	0.93	0.85	0.98	0.89	1.02	0.93	1.07	0.98
116	0.80	0.72	0.84	0.75	0.88	0.79	0.92	0.82	0.96	0.85	1.00	0.90	1.04	0.94
118	0.79	0.70	0.83	0.73	0.86	0.76	0.90	0.79	0.94	0.83	0.98	0.86	1.02	0.90
120	0.78	0.68	0.82	0.71	0.85	0.74	0.89	0.77	0.91	0.80	0.96	0.83	1.00	0.87
122	0.77	0.66	0.81	0.68	0.84	0.71	0.87	0.74	0.90	0.77	0.95	0.80	0.98	0.83
124	0.77	0.63	0.80	0.66	0.83	0.69	0.86	0.71	0.90	0.74	0.93	0.77	0.96	0.80
126	0.76	0.61	0.79	0.64	0.82	0.66	0.85	0.69	0.88	0.71	0.91	0.74	0.95	0.77
128	0.75	0.59	0.78	0.62	0.81	0.64	0.84	0.66	0.87	0.69	0.90	0.71	0.93	0.74
130	0.75	0.57	0.78	0.60	0.81	0.62	0.83	0.64	0.86	0.66	0.89	0.68	0.92	0.71
132	0.75	0.56	0.77	0.57	0.80	0.59	0.83	0.61	0.85	0.64	0.88	0.66	0.91	0.68
134	0.74	0.54	0.77	0.55	0.80	0.57	0.82	0.59	0.85	0.61	0.87	0.63	0.90	0.65
136	0.74	0.52	0.77	0.53	0.80	0.55	0.82	0.57	0.84	0.58	0.87	0.60	0.89	0.62
138	0.74	0.50	0.77	0.51	0.79	0.53	0.81	0.54	0.84	0.56	0.86	0.58	0.89	0.59
140	0.74	0.48	0.77	0.49	0.79	0.51	0.81	0.52	0.83	0.54	0.86	0.55	0.88	0.57
142	0.74	0.46	0.77	0.47	0.79	0.49	0.81	0.50	0.83	0.51	0.85	0.52	0.87	0.54
144	0.75	0.44	0.77	0.45	0.79	0.46	0.81	0.48	0.83	0.49	0.85	0.50	0.87	0.51
146	0.75	0.42	0.77	0.43	0.79	0.44	0.81	0.45	0.83	0.46	0.85	0.47	0.87	0.49
148	0.76	0.40	0.77	0.41	0.79	0.42	0.81	0.43	0.83	0.44	0.85	0.45	0.87	0.46
150	0.76	0.38	0.78	0.39	0.80	0.40	0.81	0.41	0.83	0.42	0.85	0.42	0.87	0.43
152	0.77	0.36	0.78	0.37	0.80	0.38	0.82	0.38	0.83	0.39	0.85	0.40	0.87	0.41
154	0.77	0.34	0.79	0.35	0.81	0.35	0.82	0.36	0.84	0.37	0.85	0.37	0.87	0.38
156	0.78	0.32	0.80	0.32	0.81	0.33	0.83	0.34	0.84	0.34	0.86	0.35	0.87	0.35
158	0.79	0.30	0.81	0.30	0.82	0.31	0.83	0.31	0.85	0.32	0.86	0.32	0.87	0.33
160	0.80	0.27	0.82	0.28	0.83	0.28	0.84	0.29	0.85	0.29	0.86	0.30	0.88	0.30

TABLE 5B.

Distance of an Object by Two Bearings.

Difference between the course and second bearing.	Difference between the course and first bearing.															
	62°		64°		66°		68°		70°		72°		74°		76°	
72°	5.08	4.84														
74	4.25	4.08	5.18	4.98												
76	3.65	3.54	4.32	4.19	5.26	5.10										
78	3.20	3.13	3.72	3.63	4.39	4.30	5.34	5.22								
80	2.86	2.81	3.26	3.21	3.78	3.72	4.46	4.39	5.41	5.33						
82	2.58	2.56	2.91	2.88	3.31	3.28	3.83	3.80	4.52	4.48	5.48	5.42				
84	2.36	2.34	2.63	2.61	2.96	2.94	3.36	3.35	3.88	3.86	4.57	4.55	5.54	5.51		
86	2.17	2.17	2.40	2.39	2.67	2.66	3.00	2.99	3.41	3.40	3.93	3.92	4.62	4.61	5.59	5.57
88	2.01	2.01	2.21	2.21	2.44	2.44	2.71	2.71	3.04	3.04	3.45	3.45	3.97	3.97	4.67	4.66
90	1.88	1.88	2.05	2.05	2.25	2.25	2.48	2.48	2.75	2.75	3.08	3.08	3.49	3.49	4.01	4.01
92	1.77	1.76	1.91	1.91	2.08	2.08	2.28	2.28	2.51	2.51	2.78	2.78	3.11	3.11	3.52	3.52
94	1.67	1.66	1.80	1.79	1.95	1.94	2.12	2.11	2.31	2.30	2.54	2.53	2.81	2.80	3.14	3.13
96	1.58	1.57	1.70	1.69	1.83	1.82	1.97	1.96	2.14	2.13	2.34	2.33	2.57	2.55	2.84	2.82
98	1.50	1.49	1.61	1.59	1.72	1.71	1.85	1.84	2.00	1.98	2.17	2.15	2.36	2.34	2.59	2.56
100	1.43	1.41	1.53	1.51	1.63	1.61	1.75	1.72	1.88	1.85	2.03	2.00	2.19	2.16	2.39	2.35
102	1.37	1.34	1.46	1.43	1.55	1.52	1.66	1.62	1.77	1.73	1.90	1.86	2.05	2.00	2.21	2.16
104	1.32	1.28	1.40	1.36	1.48	1.44	1.58	1.53	1.68	1.63	1.79	1.74	1.92	1.87	2.07	2.01
106	1.27	1.22	1.34	1.29	1.42	1.37	1.51	1.45	1.60	1.54	1.70	1.63	1.81	1.74	1.94	1.87
108	1.23	1.17	1.29	1.23	1.37	1.30	1.44	1.37	1.53	1.45	1.62	1.54	1.72	1.63	1.83	1.74
110	1.19	1.12	1.25	1.17	1.32	1.24	1.39	1.30	1.46	1.37	1.54	1.45	1.64	1.54	1.74	1.63
112	1.15	1.07	1.21	1.12	1.27	1.18	1.33	1.24	1.40	1.30	1.48	1.37	1.56	1.45	1.65	1.53
114	1.12	1.02	1.17	1.07	1.23	1.12	1.29	1.18	1.35	1.24	1.42	1.30	1.50	1.37	1.58	1.44
116	1.09	0.98	1.14	1.03	1.19	1.07	1.25	1.12	1.31	1.17	1.37	1.23	1.44	1.29	1.51	1.36
118	1.07	0.94	1.11	0.98	1.16	1.02	1.21	1.07	1.26	1.12	1.32	1.17	1.38	1.22	1.45	1.28
120	1.04	0.90	1.08	0.94	1.13	0.98	1.18	1.02	1.23	1.06	1.28	1.11	1.34	1.16	1.40	1.21
122	1.02	0.86	1.06	0.90	1.10	0.93	1.15	0.97	1.19	1.01	1.24	1.05	1.29	1.10	1.35	1.14
124	1.00	0.83	1.04	0.86	1.08	0.89	1.12	0.93	1.16	0.96	1.21	1.00	1.25	1.04	1.31	1.08
126	0.98	0.79	1.02	0.82	1.05	0.85	1.09	0.88	1.13	0.92	1.18	0.95	1.22	0.99	1.27	1.02
128	0.97	0.76	1.00	0.79	1.03	0.82	1.07	0.84	1.11	0.87	1.15	0.90	1.19	0.94	1.23	0.97
130	0.95	0.73	0.98	0.75	1.02	0.78	1.05	0.80	1.09	0.83	1.12	0.86	1.16	0.89	1.20	0.92
132	0.94	0.70	0.97	0.72	1.00	0.74	1.03	0.77	1.06	0.79	1.10	0.82	1.13	0.84	1.17	0.87
134	0.93	0.67	0.96	0.69	0.99	0.71	1.01	0.73	1.04	0.75	1.08	0.77	1.11	0.80	1.14	0.82
136	0.92	0.64	0.95	0.66	0.97	0.68	1.00	0.69	1.03	0.71	1.06	0.74	1.09	0.76	1.12	0.78
138	0.91	0.61	0.94	0.63	0.96	0.64	0.99	0.66	1.01	0.68	1.04	0.70	1.07	0.72	1.10	0.74
140	0.90	0.58	0.93	0.60	0.95	0.61	0.97	0.63	1.00	0.64	1.03	0.66	1.05	0.68	1.08	0.70
142	0.90	0.55	0.92	0.57	0.94	0.58	0.96	0.59	0.99	0.61	1.01	0.62	1.04	0.64	1.06	0.65
144	0.89	0.52	0.91	0.54	0.93	0.55	0.96	0.56	0.98	0.57	1.00	0.59	1.02	0.60	1.05	0.62
146	0.89	0.50	0.91	0.51	0.93	0.52	0.95	0.53	0.97	0.54	0.99	0.55	1.01	0.57	1.03	0.58
148	0.89	0.47	0.90	0.48	0.92	0.49	0.94	0.50	0.96	0.51	0.98	0.52	1.00	0.53	1.02	0.54
150	0.88	0.44	0.90	0.45	0.92	0.46	0.94	0.47	0.95	0.48	0.97	0.49	0.99	0.50	1.01	0.50
152	0.88	0.41	0.90	0.42	0.92	0.43	0.93	0.44	[illegible]	0.45	0.97	0.45	0.98	0.46	1.00	0.47
154	0.88	0.39	0.90	0.39	0.91	0.40	0.93	0.41	[illegible]	0.41	0.96	0.42	0.98	0.43	0.99	0.43
156	0.89	0.36	0.90	0.37	0.91	0.37	0.93	0.38	[illegible]	0.38	0.96	0.39	0.97	0.39	0.99	0.40
158	0.89	0.33	0.90	0.34	0.91	0.34	0.93	0.35	[illegible]	0.35	0.95	0.36	0.97	0.36	0.98	0.37
160	0.89	0.30	0.90	0.31	0.91	0.31	0.93	[illegible]	[illegible]	0.32	0.95	0.33	0.96	0.33	0.98	0.33

TABLE 5B.

Distance of an Object by Two Bearings.

Difference between the course and second bearing.	Difference between the course and first bearing.															
	78°		80°		82°		84°		86°		88°		90°		92°	
88°	5.63	5.63														
90	4.70	4.70	5.67	5.67												
92	4.04	4.04	4.74	4.73	5.70	5.70										
94	3.55	3.54	4.07	4.06	4.76	4.75	5.73	5.71								
96	3.17	3.15	3.57	3.55	4.09	4.07	4.78	4.76	5.74	5.71						
98	2.86	2.83	3.19	3.16	3.59	3.56	4.11	4.07	4.80	4.75	5.76	5.70				
100	2.61	2.57	2.88	2.84	3.20	3.16	3.61	3.55	4.12	4.06	4.81	4.73	5.76	5.67		
102	2.40	2.35	2.63	2.57	2.90	2.83	3.22	3.15	3.62	3.54	4.13	4.04	4.81	4.70	5.76	5.63
104	2.23	2.16	2.42	2.35	2.64	2.56	2.91	2.82	3.23	3.13	3.63	3.52	4.13	4.01	4.81	4.66
106	2.08	2.00	2.25	2.16	2.43	2.34	2.65	2.55	2.92	2.80	3.23	3.11	3.63	3.49	4.13	3.97
108	1.96	1.86	2.10	2.00	2.26	2.15	2.45	2.33	2.66	2.53	2.92	2.78	3.24	3.08	3.63	3.45
110	1.85	1.73	1.97	1.85	2.11	1.98	2.27	2.13	2.45	2.31	2.67	2.51	2.92	2.75	3.23	3.04
112	1.75	1.62	1.86	1.72	1.98	1.83	2.12	1.96	2.28	2.11	2.46	2.28	2.67	2.48	2.92	2.71
114	1.66	1.52	1.76	1.61	1.87	1.71	1.99	1.82	2.12	1.94	2.28	2.08	2.46	2.25	2.67	2.44
116	1.59	1.43	1.68	1.51	1.77	1.59	1.88	1.69	2.00	1.79	2.13	1.91	2.28	2.05	2.46	2.21
118	1.52	1.34	1.60	1.41	1.68	1.49	1.78	1.57	1.88	1.66	2.00	1.76	2.13	1.88	2.28	2.01
120	1.46	1.27	1.53	1.33	1.61	1.39	1.69	1.47	1.78	1.54	1.89	1.63	2.00	1.73	2.13	1.84
122	1.41	1.19	1.47	1.25	1.54	1.31	1.62	1.37	1.70	1.44	1.79	1.52	1.89	1.60	2.00	1.70
124	1.36	1.13	1.42	1.18	1.48	1.23	1.55	1.28	1.62	1.34	1.70	1.41	1.79	1.48	1.89	1.56
126	1.32	1.06	1.37	1.11	1.43	1.15	1.48	1.20	1.55	1.26	1.62	1.31	1.70	1.38	1.79	1.45
128	1.28	1.01	1.33	1.04	1.38	1.08	1.43	1.13	1.49	1.17	1.55	1.23	1.62	1.28	1.70	1.34
130	1.24	0.95	1.29	0.98	1.33	1.02	1.38	1.06	1.44	1.10	1.49	1.14	1.56	1.19	1.62	1.24
132	1.21	0.90	1.25	0.93	1.29	0.96	1.34	0.99	1.39	1.08	1.44	1.07	1.49	1.11	1.55	1.16
134	1.18	0.85	1.22	0.88	1.26	0.90	1.30	0.93	1.34	0.97	1.39	1.00	1.44	1.04	1.49	1.07
136	1.15	0.80	1.19	0.83	1.22	0.85	1.26	0.88	1.30	0.90	1.34	0.93	1.39	0.97	1.44	1.00
138	1.13	0.76	1.16	0.78	1.19	0.80	1.23	0.82	1.27	0.85	1.30	0.87	1.35	0.90	1.39	0.93
140	1.11	0.71	1.14	0.73	1.17	0.75	1.20	0.77	1.23	0.79	1.27	0.82	1.31	0.84	1.34	0.86
142	1.09	0.67	1.12	0.69	1.14	0.70	1.17	0.72	1.20	0.74	1.24	0.76	1.27	0.78	1.30	0.80
144	1.07	0.63	1.10	0.64	1.12	0.66	1.15	0.67	1.18	0.69	1.21	0.71	1.24	0.73	1.27	0.75
146	1.05	0.59	1.08	0.60	1.10	0.62	1.13	0.63	1.15	0.64	1.18	0.66	1.21	0.67	1.24	0.69
148	1.04	0.55	1.06	0.56	1.08	0.57	1.11	0.59	1.13	0.60	1.15	0.61	1.18	0.62	1.21	0.64
150	1.03	0.51	1.05	0.52	1.07	0.53	1.09	0.54	1.11	0.55	1.13	0.57	1.15	0.58	1.18	0.59
152	1.02	0.48	1.04	0.49	1.05	0.49	1.07	0.50	1.09	0.51	1.11	0.52	1.13	0.53	1.15	0.54
154	1.01	0.44	1.02	0.45	1.04	0.46	1.06	0.46	1.08	0.47	1.09	0.48	1.11	0.49	1.13	0.50
156	1.00	0.41	1.01	0.41	1.03	0.42	1.05	0.43	1.06	0.43	1.08	0.44	1.09	0.45	1.11	0.45
158	0.99	0.37	1.01	0.38	1.02	0.38	1.03	0.39	1.05	0.39	1.06	0.40	1.08	0.40	1.09	0.41
160	0.99	0.34	1.00	0.34	1.01	0.35	1.02	0.35	1.04	0.35	1.05	0.36	1.06	0.36	1.08	0.37

	94°		96°		98°		100°		102°		104°		106°		108°	
104°	5.74	5.57														
106	4.80	4.61	5.78	5.51												
108	4.12	3.92	4.78	4.55	5.70	5.42										
110	3.62	3.40	4.11	3.86	4.76	4.48	5.67	5.33								
112	3.23	2.99	3.61	3.35	4.09	3.80	4.74	4.40	5.63	5.22						
114	2.92	2.66	3.22	2.94	3.59	3.28	4.07	3.72	4.70	4.30	5.59	5.10				
116	2.66	2.39	2.91	2.61	3.20	2.88	3.57	3.21	4.04	3.63	4.67	4.19	5.54	4.98		
118	2.45	2.17	2.65	2.34	2.90	2.56	3.19	2.81	3.55	3.13	4.01	3.54	4.62	4.08	5.48	4.84
120	2.28	1.97	2.45	2.12	2.64	2.29	2.88	2.49	3.17	2.74	3.52	3.05	3.97	3.44	4.57	3.96
122	2.12	1.80	2.27	1.92	2.43	2.06	2.63	2.23	2.86	2.43	3.14	2.66	3.49	2.96	3.93	3.33
124	2.00	1.65	2.12	1.76	2.26	1.87	2.42	2.01	2.61	2.16	2.84	2.35	3.11	2.58	3.45	2.86
126	1.88	1.52	1.99	1.61	2.11	1.71	2.25	1.82	2.40	1.95	2.59	2.10	2.81	2.27	3.08	2.49
128	1.78	1.41	1.88	1.48	1.98	1.56	2.10	1.65	2.23	1.76	2.39	1.88	2.57	2.02	2.78	2.19
130	1.70	1.30	1.78	1.36	1.87	1.43	1.97	1.51	2.08	1.60	2.21	1.70	2.36	1.81	2.54	1.94
132	1.62	1.20	1.69	1.26	1.77	1.32	1.86	1.38	1.96	1.45	2.07	1.54	2.19	1.63	2.34	1.74
134	1.55	1.12	1.62	1.16	1.68	1.21	1.76	1.27	1.85	1.33	1.94	1.40	2.05	1.47	2.17	1.56
136	1.49	1.04	1.55	1.07	1.61	1.12	1.68	1.16	1.75	1.22	1.83	1.27	1.92	1.34	2.03	1.41
138	1.44	0.96	1.49	0.99	1.54	1.03	1.60	1.07	1.66	1.11	1.74	1.16	1.81	1.21	1.90	1.27
140	1.39	0.89	1.43	0.92	1.48	0.95	1.53	0.98	1.59	1.02	1.65	1.06	1.72	1.10	1.79	1.15
142	1.34	0.83	1.38	0.85	1.43	0.88	1.47	0.91	1.52	0.94	1.58	0.97	1.64	1.01	1.70	1.05
144	1.30	0.77	1.34	0.79	1.38	0.81	1.42	0.83	1.46	0.86	1.51	0.89	1.56	0.92	1.62	0.95
146	1.27	0.71	1.30	0.73	1.33	0.75	1.37	0.77	1.41	0.79	1.45	0.81	1.50	0.84	1.54	0.86
148	1.23	0.65	1.26	0.67	1.29	0.69	1.33	0.70	1.36	0.72	1.40	0.74	1.44	0.76	1.48	0.78
150	1.20	0.60	1.23	0.61	1.26	0.63	1.29	0.64	1.32	0.66	1.35	0.67	1.38	0.69	1.42	0.71
152	1.18	0.55	1.20	0.56	1.22	0.57	1.25	0.59	1.28	0.60	1.31	0.61	1.34	0.63	1.37	0.64
154	1.15	0.50	1.17	0.51	1.19	0.52	1.22	0.53	1.24	0.54	1.27	0.56	1.29	0.57	1.32	0.58
156	1.13	0.46	1.15	0.47	1.17	0.47	1.19	0.48	1.21	0.49	1.23	0.50	1.25	0.51	1.28	0.52
158	1.11	0.42	1.13	0.42	1.14	0.43	1.16	0.44	1.18	0.44	1.20	0.45	1.22	0.46	1.24	0.47
160	1.09	0.37	1.11	0.38	1.12	0.38	1.14	0.39	1.15	0.39	1.17	0.40	1.19	0.41	1.21	0.41

TABLE 5B.

Distance of an Object by Two Bearings.

Difference between the course and second bearing.	Difference between the course and first bearing.													
	110°		112°		114°		116°		118°		120°		122°	
120°	5.41	4.69												
122	4.52	3.83	5.34	4.53										
124	3.88	3.22	4.46	3.70	5.26	4.36								
126	3.41	2.76	3.83	3.10	4.39	3.55	5.18	4.19						
128	3.04	2.40	3.36	2.65	3.78	2.98	4.32	3.41	5.08	4.01				
130	2.75	2.10	3.00	2.30	3.31	2.54	3.72	2.85	4.25	3.25	4.99	3.82		
132	2.51	1.86	2.71	2.01	2.96	2.20	3.26	2.42	3.65	2.71	4.17	3.10	4.88	3.63
134	2.31	1.66	2.48	1.78	2.67	1.92	2.91	2.09	3.20	2.30	3.58	2.57	4.08	2.93
136	2.14	1.49	2.28	1.58	2.44	1.69	2.63	1.83	2.86	1.98	3.14	2.18	3.51	2.44
138	2.00	1.34	2.12	1.42	2.25	1.50	2.40	1.61	2.58	1.73	2.80	1.88	3.08	2.06
140	1.88	1.21	1.97	1.27	2.08	1.34	2.21	1.42	2.36	1.52	2.53	1.63	2.74	1.76
142	1.77	1.09	1.85	1.14	1.95	1.20	2.05	1.26	2.17	1.34	2.31	1.42	2.48	1.53
144	1.68	0.99	1.75	1.03	1.83	1.07	1.91	1.13	2.01	1.18	2.13	1.25	2.26	1.33
146	1.60	0.89	1.66	0.93	1.72	0.96	1.80	1.01	1.88	1.05	1.98	1.10	2.08	1.17
148	1.53	0.81	1.58	0.84	1.63	0.87	1.70	0.90	1.77	0.94	1.84	0.98	1.93	1.03
150	1.46	0.73	1.51	0.75	1.55	0.78	1.61	0.80	1.67	0.83	1.73	0.87	1.81	0.90
152	1.40	0.66	1.44	0.68	1.48	0.70	1.53	0.72	1.58	0.74	1.63	0.77	1.70	0.80
154	1.35	0.59	1.39	0.61	1.42	0.62	1.46	0.64	1.50	0.66	1.55	0.68	1.60	0.70
156	1.31	0.53	1.33	0.54	1.37	0.56	1.40	0.57	1.43	0.58	1.47	0.60	1.52	0.62
158	1.26	0.47	1.29	0.48	1.32	0.49	1.34	0.50	1.37	0.51	1.41	0.53	1.44	0.54
160	1.23	0.42	1.25	0.43	1.27	0.43	1.29	0.44	1.32	0.45	1.35	0.46	1.38	0.47
	124°		126°		128°		130°		132°		134°		136°	
134°	4.77	3.43												
136	3.99	2.77	4.66	3.23										
138	3.43	2.29	3.89	2.60	4.54	3.04								
140	3.01	1.93	3.34	2.15	3.79	2.44	4.41	2.84						
142	2.68	1.65	2.94	1.81	3.26	2.01	3.63	2.27	4.28	2.63				
144	2.42	1.42	2.62	1.54	2.86	1.68	3.17	1.86	3.57	2.10	4.14	2.43		
146	2.21	1.24	2.37	1.32	2.55	1.43	2.78	1.55	3.07	1.72	3.46	1.93	4.00	2.24
148	2.04	1.08	2.16	1.14	2.30	1.22	2.48	1.31	2.70	1.43	2.97	1.58	3.34	1.77
150	1.89	0.95	1.99	0.99	2.10	1.05	2.24	1.12	2.40	1.20	2.61	1.30	2.87	1.44
152	1.77	0.83	1.85	0.87	1.94	0.91	2.04	0.96	2.17	1.02	2.33	1.09	2.52	1.18
154	1.66	0.73	1.72	0.76	1.80	0.79	1.88	0.83	1.98	0.87	2.10	0.92	2.25	0.99
156	1.56	0.64	1.62	0.66	1.68	0.68	1.75	0.71	1.83	0.74	1.92	0.78	2.03	0.83
158	1.48	0.56	1.53	0.57	1.58	0.59	1.63	0.61	1.70	0.64	1.77	0.66	1.85	0.69
160	1.41	0.48	1.45	0.49	1.49	0.51	1.53	0.52	1.58	0.54	1.64	0.56	1.71	0.58
	138°		140°		142°		144°		146°		148°		150°	
148°	3.85	2.04												
150	3.22	1.61	3.70	1.85										
152	2.77	1.30	3.09	1.45	3.55	1.66								
154	2.43	1.06	2.66	1.16	2.96	1.30	3.38	1.48						
156	2.17	0.88	2.33	0.95	2.54	1.04	2.83	1.15	3.22	1.31				
158	1.96	0.73	2.08	0.78	2.23	0.84	2.43	0.91	2.69	1.01	3.05	1.14		
160	1.79	0.61	1.88	0.64	1.99	0.68	2.13	0.73	2.31	0.79	2.55	0.87	2.88	0.98

TABLE 6.

Distance of Visibility of Objects at Sea.

Height, feet.	Nautical miles.	Statute miles.	Height, feet.	Nautical miles.	Statute miles.	Height, feet.	Nautical miles.	Statute miles.
1	1.1	1.3	100	11.5	13.2	760	31.6	36.4
2	1.7	1.9	105	11.7	13.5	780	32.0	36.9
3	2.0	2.3	110	12.0	13.8	800	32.4	37.3
4	2.3	2.6	115	12.3	14.1	820	32.8	37.8
5	2.5	2.9	120	12.6	14.5	840	33.2	38.3
6	2.8	3.2	125	12.9	14.8	860	33.6	38.7
7	2.9	3.5	130	13.1	15.1	880	34.0	39.2
8	3.1	3.7	135	13.3	15.3	900	34.4	39.6
9	3.5	4.0	140	13.6	15.6	920	34.7	40.0
10	3.6	4.2	145	13.8	15.9	940	35.2	40.5
11	3.8	4.4	150	14.1	16.2	960	35.5	40.9
12	4.0	4.6	160	14.5	16.7	980	35.9	41.3
13	4.2	4.8	170	14.9	17.2	1,000	36.2	41.7
14	4.3	4.9	180	15.4	17.7	1,100	38.0	43.8
15	4.4	5.1	190	15.8	18.2	1,200	39.6	45.6
16	4.6	5.3	200	16.2	18.7	1,300	41.3	47.6
17	4.7	5.4	210	16.6	19.1	1,400	42.9	49.4
18	4.9	5.6	220	17.0	19.6	1,500	44.4	51.1
19	5.0	5.8	230	17.4	20.0	1,600	45.8	52.8
20	5.1	5.9	240	17.7	20.4	1,700	47.2	54.4
21	5.3	6.1	250	18.2	20.9	1,800	48.6	56.0
22	5.4	6.2	260	18.5	21.3	1,900	49.9	57.5
23	5.5	6.3	270	18.9	21.7	2,000	51.2	59.0
24	5.6	6.5	280	19.2	22.1	2,100	52.5	60.5
25	5.7	6.6	290	19.6	22.5	2,200	53.8	61.9
26	5.8	6.7	300	19.9	22.9	2,300	55.0	63.3
27	6.0	6.9	310	20.1	23.2	2,400	56.2	64.7
28	6.1	7.0	320	20.5	23.6	2,500	57.3	66.0
29	6.2	7.1	330	20.8	24.0	2,600	58.5	67.3
30	6.3	7.2	340	21.1	24.3	2,700	59.6	68.6
31	6.4	7.3	350	21.5	24.7	2,800	60.6	69.8
32	6.5	7.5	360	21.7	25.0	2,900	61.8	71.1
33	6.6	7.6	370	22.1	25.4	3,000	62.8	72.3
34	6.7	7.7	380	22.3	25.7	3,100	63.8	73.5
35	6.8	7.8	390	22.7	26.1	3,200	64.9	74.7
36	6.9	7.9	400	22.9	26.4	3,300	65.9	75.9
37	6.9	8.0	410	23.2	26.7	3,400	66.9	77.0
38	7.0	8.1	420	23.5	27.1	3,500	67.8	78.1
39	7.1	8.2	430	23.8	27.4	3,600	68.8	79.2
40	7.2	8.3	440	24.1	27.7	3,700	69.7	80.3
41	7.3	8.4	450	24.3	28.0	3,800	70.7	81.4
42	7.4	8.5	460	24.6	28.3	3,900	71.6	82.4
43	7.5	8.7	470	24.8	28.6	4,000	72.5	83.5
44	7.6	8.8	480	25.1	28.9	4,100	73.4	84.5
45	7.7	8.9	490	25.4	29.2	4,200	74.3	85.6
46	7.8	9.0	500	25.6	29.5	4,300	75.2	86.6
47	7.9	9.0	520	26.1	30.1	4,400	76.1	87.6
48	7.9	9.1	540	26.7	30.7	4,500	76.9	88.5
49	8.0	9.2	560	27.1	31.2	4,600	77.7	89.5
50	8.1	9.3	580	27.6	31.8	4,700	78.6	90.5
55	8.5	9.8	600	28.0	32.3	4,800	79.4	91.4
60	8.9	10.2	620	28.6	32.9	4,900	80.2	92.4
65	9.2	10.6	640	29.0	33.4	5,000	81.0	93.3
70	9.6	11.0	660	29.4	33.9	6,000	88.8	102.2
75	9.9	11.4	680	29.9	34.4	7,000	96.0	110.5
80	10.3	11.8	700	30.3	34.9	8,000	102.6	118.1
85	10.6	12.2	720	30.7	35.4	9,000	108.7	125.2
90	10.9	12.5	740	31.1	35.9	10,000	114.6	132.0
95	11.2	12.9						

TABLE 7.

For converting Arc into Time, and the reverse.

°	H. M.	°	H. M.	°	H. M.	°	H. M.	°	H. M.	°	H. M.
′	M. S.	′	M. S.	′	M. S.	′	M. S.	′	M. S.	′	M. S.
″	S. $\frac{1}{60}$	″	S. $\frac{1}{60}$	″	S. $\frac{1}{60}$	″	S. $\frac{1}{60}$	″	S. $\frac{1}{60}$	″	S. $\frac{1}{60}$
1	0 4	61	4 4	121	8 4	181	12 4	241	16 4	301	20 4
2	0 8	62	4 8	122	8 8	182	12 8	242	16 8	302	20 8
3	0 12	63	4 12	123	8 12	183	12 12	243	16 12	303	20 12
4	0 16	64	4 16	124	8 16	184	12 16	244	16 16	304	20 16
5	0 20	65	4 20	125	8 20	185	12 20	245	16 20	305	20 20
6	0 24	66	4 24	126	8 24	186	12 24	246	16 24	306	20 24
7	0 28	67	4 28	127	8 28	187	12 28	247	16 28	307	20 28
8	0 32	68	4 32	128	8 32	188	12 32	248	16 32	308	20 32
9	0 36	69	4 36	129	8 36	189	12 36	249	16 36	309	20 36
10	0 40	70	4 40	130	8 40	190	12 40	250	16 40	310	20 40
11	0 44	71	4 44	131	8 44	191	12 44	251	16 44	311	20 44
12	0 48	72	4 48	132	8 48	192	12 48	252	16 48	312	20 48
13	0 52	73	4 52	133	8 52	193	12 52	253	16 52	313	20 52
14	0 56	74	4 56	134	8 56	194	12 56	254	16 56	314	20 56
15	1 0	75	5 0	135	9 0	195	13 0	255	17 0	315	21 0
16	1 4	76	5 4	136	9 4	196	13 4	256	17 4	316	21 4
17	1 8	77	5 8	137	9 8	197	13 8	257	17 8	317	21 8
18	1 12	78	5 12	138	9 12	198	13 12	258	17 12	318	21 12
19	1 16	79	5 16	139	9 16	199	13 16	259	17 16	319	21 16
20	1 20	80	5 20	140	9 20	200	13 20	260	17 20	320	21 20
21	1 24	81	5 24	141	9 24	201	13 24	261	17 24	321	21 24
22	1 28	82	5 28	142	9 28	202	13 28	262	17 28	322	21 28
23	1 32	83	5 32	143	9 32	203	13 32	263	17 32	323	21 32
24	1 36	84	5 36	144	9 36	204	13 36	264	17 36	324	21 36
25	1 40	85	5 40	145	9 40	205	13 40	265	17 40	325	21 40
26	1 44	86	5 44	146	9 44	206	13 44	266	17 44	326	21 44
27	1 48	87	5 48	147	9 48	207	13 48	267	17 48	327	21 48
28	1 52	88	5 52	148	9 52	208	13 52	268	17 52	328	21 52
29	1 56	89	5 56	149	9 56	209	13 56	269	17 56	329	21 56
30	2 0	90	6 0	150	10 0	210	14 0	270	18 0	330	22 0
31	2 4	91	6 4	151	10 4	211	14 4	271	18 4	331	22 4
32	2 8	92	6 8	152	10 8	212	14 8	272	18 8	332	22 8
33	2 12	93	6 12	153	10 12	213	14 12	273	18 12	333	22 12
34	2 16	94	6 16	154	10 16	214	14 16	274	18 16	334	22 16
35	2 20	95	6 20	155	10 20	215	14 20	275	18 20	335	22 20
36	2 24	96	6 24	156	10 24	216	14 24	276	18 24	336	22 24
37	2 28	97	6 28	157	10 28	217	14 28	277	18 28	337	22 28
38	2 32	98	6 32	158	10 32	218	14 32	278	18 32	338	22 32
39	2 36	99	6 36	159	10 36	219	14 36	279	18 36	339	22 36
40	2 40	100	6 40	160	10 40	220	14 40	280	18 40	340	22 40
41	2 44	101	6 44	161	10 44	221	14 44	281	18 44	341	22 44
42	2 48	102	6 48	162	10 48	222	14 48	282	18 48	342	22 48
43	2 52	103	6 52	163	10 52	223	14 52	283	18 52	343	22 52
44	2 56	104	6 56	164	10 56	224	14 56	284	18 56	344	22 56
45	3 0	105	7 0	165	11 0	225	15 0	285	19 0	345	23 0
46	3 4	106	7 4	166	11 4	226	15 4	286	19 4	346	23 4
47	3 8	107	7 8	167	11 8	227	15 8	287	19 8	347	23 8
48	3 12	108	7 12	168	11 12	228	15 12	288	19 12	348	23 12
49	3 16	109	7 16	169	11 16	229	15 16	289	19 16	349	23 16
50	3 20	110	7 20	170	11 20	230	15 20	290	19 20	350	23 20
51	3 24	111	7 24	171	11 24	231	15 24	291	19 24	351	23 24
52	3 28	112	7 28	172	11 28	232	15 28	292	19 28	352	23 28
53	3 32	113	7 32	173	11 32	233	15 32	293	19 32	353	23 32
54	3 36	114	7 36	174	11 36	234	15 36	294	19 36	354	23 36
55	3 40	115	7 40	175	11 40	235	15 40	295	19 40	355	23 40
56	3 44	116	7 44	176	11 44	236	15 44	296	19 44	356	23 44
57	3 48	117	7 48	177	11 48	237	15 48	297	19 48	357	23 48
58	3 52	118	7 52	178	11 52	238	15 52	298	19 52	358	23 52
59	3 56	119	7 56	179	11 56	239	15 56	299	19 56	359	23 56
60	4 0	120	8 0	180	12 0	240	16 0	300	20 0	360	24 0

NOTE.—When turning seconds of arc into time, and vice versa, it should be remembered that the fractions are sixtieths; thus, the value in time of 42″ is not $2^s.48$, but $2^s\frac{48}{60}=2^s.8$.

TABLE 8.

Sidereal into Mean Solar Time.

To be subtracted from a sidereal time interval.

Sidereal.	0^h	1^h	2^h	3^h	4^h	5^h	6^h	7^h	For seconds.	
m.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	s.	s.
0	0 0.000	0 9.830	0 19.659	0 29.489	0 39.318	0 49.148	0 58.977	1 8.807		
1	0 0.164	0 9.993	0 19.823	0 29.653	0 39.482	0 49.312	0 59.141	1 8.971	1	0.003
2	0 0.328	0 10.157	0 19.987	0 29.816	0 39.646	0 49.475	0 59.305	1 9.135	2	.005
3	0 0.491	0 10.321	0 20.151	0 29.980	0 39.810	0 49.639	0 59.469	1 9.298	3	.008
4	0 0.655	0 10.485	0 20.314	0 30.144	0 39.974	0 49.803	0 59.633	1 9.462	4	.011
5	0 0.819	0 10.649	0 20.478	0 30.308	0 40.137	0 49.967	0 59.796	1 9.626	5	.014
6	0 0.983	0 10.813	0 20.642	0 30.472	0 40.301	0 50.131	0 59.960	1 9.790	6	.016
7	0 1.147	0 10.976	0 20.806	0 30.635	0 40.465	0 50.295	1 0.124	1 9.954	7	.019
8	0 1.311	0 11.140	0 20.970	0 30.799	0 40.629	0 50.458	1 0.288	1 10.118	8	.022
9	0 1.474	0 11.304	0 21.134	0 30.963	0 40.793	0 50.622	1 0.452	1 10.281	9	.025
10	0 1.638	0 11.468	0 21.297	0 31.127	0 40.956	0 50.786	1 0.616	1 10.445	10	.027
11	0 1.802	0 11.632	0 21.461	0 31.291	0 41.120	0 50.950	1 0.779	1 10.609	11	.030
12	0 1.966	0 11.795	0 21.625	0 31.455	0 41.284	0 51.114	1 0.943	1 10.773	12	.033
13	0 2.130	0 11.959	0 21.789	0 31.618	0 41.448	0 51.278	1 1.107	1 10.937	13	.035
14	0 2.294	0 12.123	0 21.953	0 31.782	0 41.612	0 51.441	1 1.271	1 11.100	14	.038
15	0 2.457	0 12.287	0 22.117	0 31.946	0 41.776	0 51.605	1 1.435	1 11.264	15	.041
16	0 2.621	0 12.451	0 22.280	0 32.110	0 41.939	0 51.769	1 1.599	1 11.428	16	.044
17	0 2.785	0 12.615	0 22.444	0 32.274	0 42.103	0 51.933	1 1.762	1 11.592	17	.046
18	0 2.949	0 12.778	0 22.608	0 32.438	0 42.267	0 52.097	1 1.926	1 11.756	18	.049
19	0 3.113	0 12.942	0 22.772	0 32.601	0 42.431	0 52.260	1 2.090	1 11.920	19	.052
20	0 3.277	0 13.106	0 22.936	0 32.765	0 42.595	0 52.424	1 2.254	1 12.083	20	.055
21	0 3.440	0 13.270	0 23.099	0 32.929	0 42.759	0 52.588	1 2.418	1 12.247	21	.057
22	0 3.604	0 13.434	0 23.263	0 33.093	0 42.922	0 52.752	1 2.582	1 12.411	22	.060
23	0 3.768	0 13.598	0 23.427	0 33.257	0 43.086	0 52.916	1 2.745	1 12.575	23	.063
24	0 3.932	0 13.761	0 23.591	0 33.420	0 43.250	0 53.080	1 2.909	1 12.739	24	.066
25	0 4.096	0 13.925	0 23.755	0 33.584	0 43.414	0 53.243	1 3.073	1 12.903	25	.068
26	0 4.259	0 14.089	0 23.919	0 33.748	0 43.578	0 53.407	1 3.237	1 13.066	26	.071
27	0 4.423	0 14.253	0 24.082	0 33.912	0 43.742	0 53.571	1 3.401	1 13.230	27	.074
28	0 4.587	0 14.417	0 24.246	0 34.076	0 43.905	0 53.735	1 3.564	1 13.394	28	.076
29	0 4.751	0 14.581	0 24.410	0 34.240	0 44.069	0 53.899	1 3.728	1 13.558	29	.079
30	0 4.915	0 14.744	0 24.574	0 34.403	0 44.233	0 54.063	1 3.892	1 13.722	30	.082
31	0 5.079	0 14.908	0 24.738	0 34.567	0 44.397	0 54.226	1 4.056	1 13.886	31	.085
32	0 5.242	0 15.072	0 24.902	0 34.731	0 44.561	0 54.390	1 4.220	1 14.049	32	.087
33	0 5.406	0 15.236	0 25.065	0 34.895	0 44.724	0 54.554	1 4.384	1 14.213	33	.090
34	0 5.570	0 15.400	0 25.229	0 35.059	0 44.888	0 54.718	1 4.547	1 14.377	34	.093
35	0 5.734	0 15.563	0 25.393	0 35.223	0 45.052	0 54.882	1 4.711	1 14.541	35	.096
36	0 5.898	0 15.727	0 25.557	0 35.386	0 45.216	0 55.046	1 4.875	1 14.705	36	.098
37	0 6.062	0 15.891	0 25.721	0 35.550	0 45.380	0 55.209	1 5.039	1 14.868	37	.101
38	0 6.225	0 16.055	0 25.885	0 35.714	0 45.544	0 55.373	1 5.203	1 15.032	38	.104
39	0 6.389	0 16.219	0 26.048	0 35.878	0 45.707	0 55.537	1 5.367	1 15.196	39	.106
40	0 6.553	0 16.383	0 26.212	0 36.042	0 45.871	0 55.701	1 5.530	1 15.360	40	.109
41	0 6.717	0 16.546	0 26.376	0 36.206	0 46.035	0 55.865	1 5.694	1 15.524	41	.112
42	0 6.881	0 16.710	0 26.540	0 36.369	0 46.199	0 56.028	1 5.858	1 15.688	42	.115
43	0 7.045	0 16.874	0 26.704	0 36.533	0 46.363	0 56.192	1 6.022	1 15.851	43	.117
44	0 7.208	0 17.038	0 26.867	0 36.697	0 46.527	0 56.356	1 6.186	1 16.015	44	.120
45	0 7.372	0 17.202	0 27.031	0 36.861	0 46.690	0 56.520	1 6.350	1 16.179	45	.123
46	0 7.536	0 17.366	0 27.195	0 37.025	0 46.854	0 56.684	1 6.513	1 16.343	46	.126
47	0 7.700	0 17.529	0 27.359	0 37.188	0 47.018	0 56.848	1 6.677	1 16.507	47	.128
48	0 7.864	0 17.693	0 27.523	0 37.352	0 47.182	0 57.011	1 6.841	1 16.671	48	.131
49	0 8.027	0 17.857	0 27.687	0 37.516	0 47.346	0 57.175	1 7.005	1 16.834	49	.134
50	0 8.191	0 18.021	0 27.850	0 37.680	0 47.510	0 57.339	1 7.169	1 16.998	50	.137
51	0 8.355	0 18.185	0 28.014	0 37.844	0 47.673	0 57.503	1 7.332	1 17.162	51	.139
52	0 8.519	0 18.349	0 28.178	0 38.008	0 47.837	0 57.667	1 7.496	1 17.326	52	.142
53	0 8.683	0 18.512	0 28.342	0 38.171	0 48.001	0 57.831	1 7.660	1 17.490	53	.145
54	0 8.847	0 18.676	0 28.506	0 38.335	0 48.165	0 57.994	1 7.824	1 17.654	54	.147
55	0 9.010	0 18.840	0 28.670	0 38.499	0 48.329	0 58.158	1 7.988	1 17.817	55	.150
56	0 9.174	0 19.004	0 28.833	0 38.663	0 48.492	0 58.322	1 8.152	1 17.981	56	.153
57	0 9.338	0 19.168	0 28.997	0 38.827	0 48.656	0 58.486	1 8.315	1 18.145	57	.156
58	0 9.502	0 19.331	0 29.161	0 38.991	0 48.820	0 58.650	1 8.479	1 18.309	58	.158
59	0 9.666	0 19.495	0 29.325	0 39.154	0 48.984	0 58.814	1 8.643	1 18.473	59	0.161

TABLE 8.

Sidereal into Mean Solar Time.

Sidereal.	To be subtracted from a sidereal time interval.									
	8^{h}	9^{h}	10^{h}	11^{h}	12^{h}	13^{h}	14^{h}	15^{h}	For seconds.	
m.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	s.	s.
0	1 18.636	1 28.466	1 38.296	1 48.125	1 57.955	2 7.784	2 17.614	2 27.443		
1	1 18.800	1 28.630	1 38.459	1 48.289	1 58.119	2 7.948	2 17.778	2 27.607	1	0.003
2	1 18.964	1 28.794	1 38.623	1 48.453	1 58.282	2 8.112	2 17.941	2 27.771	2	.005
3	1 19.128	1 28.958	1 38.787	1 48.617	1 58.446	2 8.276	2 18.105	2 27.935	3	.008
4	1 19.292	1 29.121	1 38.951	1 48.780	1 58.610	2 8.440	2 18.269	2 28.099	4	.011
5	1 19.456	1 29.285	1 39.115	1 48.944	1 58.774	2 8.603	2 18.433	2 28.263	5	.014
6	1 19.619	1 29.449	1 39.279	1 49.108	1 58.938	2 8.767	2 18.597	2 28.426	6	.016
7	1 19.783	1 29.613	1 39.442	1 49.272	1 59.101	2 8.931	2 18.761	2 28.590	7	.019
8	1 19.947	1 29.777	1 39.606	1 49.436	1 59.265	2 9.095	2 18.924	2 28.754	8	.022
9	1 20.111	1 29.940	1 39.770	1 49.600	1 59.429	2 9.259	2 19.088	2 28.918	9	.025
10	1 20.275	1 30.104	1 39.934	1 49.763	1 59.593	2 9.423	2 19.252	2 29.082	10	.027
11	1 20.439	1 30.268	1 40.098	1 49.927	1 59.757	2 9.586	2 19.416	2 29.245	11	.030
12	1 20.602	1 30.432	1 40.261	1 50.091	1 59.921	2 9.750	2 19.580	2 29.409	12	.033
13	1 20.766	1 30.596	1 40.425	1 50.255	2 0.084	2 9.914	2 19.744	2 29.573	13	.035
14	1 20.930	1 30.760	1 40.589	1 50.419	2 0.248	2 10.078	2 19.907	2 29.737	14	.038
15	1 21.094	1 30.923	1 40.753	1 50.583	2 0.412	2 10.242	2 20.071	2 29.901	15	.041
16	1 21.258	1 31.087	1 40.917	1 50.746	2 0.576	2 10.405	2 20.235	2 30.065	16	.044
17	1 21.422	1 31.251	1 41.081	1 50.910	2 0.740	2 10.569	2 20.399	2 30.228	17	.046
18	1 21.585	1 31.415	1 41.244	1 51.074	2 0.904	2 10.733	2 20.563	2 30.392	18	.049
19	1 21.749	1 31.579	1 41.408	1 51.238	2 1.067	2 10.897	2 20.727	2 30.556	19	.052
20	1 21.913	1 31.743	1 41.572	1 51.402	2 1.231	2 11.061	2 20.890	2 30.720	20	.055
21	1 22.077	1 31.906	1 41.736	1 51.565	2 1.395	2 11.225	2 21.054	2 30.884	21	.057
22	1 22.241	1 32.070	1 41.900	1 51.729	2 1.559	2 11.388	2 21.218	2 31.048	22	.060
23	1 22.404	1 32.234	1 42.064	1 51.893	2 1.723	2 11.552	2 21.382	2 31.211	23	.063
24	1 22.568	1 32.398	1 42.227	1 52.057	2 1.887	2 11.716	2 21.546	2 31.375	24	.066
25	1 22.732	1 32.562	1 42.391	1 52.221	2 2.050	2 11.880	2 21.709	2 31.539	25	.068
26	1 22.896	1 32.726	1 42.555	1 52.385	2 2.214	2 12.044	2 21.873	2 31.703	26	.071
27	1 23.060	1 32.889	1 42.719	1 52.548	2 2.378	2 12.208	2 22.037	2 31.867	27	.074
28	1 23.224	1 33.053	1 42.883	1 52.712	2 2.542	2 12.371	2 22.201	2 32.031	28	.076
29	1 23.387	1 33.217	1 43.047	1 52.876	2 2.706	2 12.535	2 22.365	2 32.194	29	.079
30	1 23.551	1 33.381	1 43.210	1 53.040	2 2.869	2 12.699	2 22.529	2 32.358	30	.082
31	1 23.715	1 33.545	1 43.374	1 53.204	2 3.033	2 12.863	2 22.692	2 32.522	31	.085
32	1 23.879	1 33.708	1 43.538	1 53.368	2 3.197	2 13.027	2 22.856	2 32.686	32	.087
33	1 24.043	1 33.872	1 43.702	1 53.531	2 3.361	2 13.191	2 23.020	2 32.850	33	.090
34	1 24.207	1 34.036	1 43.866	1 53.695	2 3.525	2 13.354	2 23.184	2 33.013	34	.093
35	1 24.370	1 34.200	1 44.029	1 53.859	2 3.689	2 13.518	2 23.348	2 33.177	35	.096
36	1 24.534	1 34.364	1 44.193	1 54.023	2 3.852	2 13.682	2 23.512	2 33.341	36	.098
37	1 24.698	1 34.528	1 44.357	1 54.187	2 4.016	2 13.846	2 23.675	2 33.505	37	.101
38	1 24.862	1 34.691	1 44.521	1 54.351	2 4.180	2 14.010	2 23.839	2 33.669	38	.104
39	1 25.026	1 34.855	1 44.685	1 54.514	2 4.344	2 14.173	2 24.003	2 33.833	39	.106
40	1 25.190	1 35.019	1 44.849	1 54.678	2 4.508	2 14.337	2 24.167	2 33.996	40	.109
41	1 25.353	1 35.183	1 45.012	1 54.842	2 4.672	2 14.501	2 24.331	2 34.160	41	.112
42	1 25.517	1 35.347	1 45.176	1 55.006	2 4.835	2 14.665	2 24.495	2 34.324	42	.115
43	1 25.681	1 35.511	1 45.340	1 55.170	2 4.999	2 14.829	2 24.658	2 34.488	43	.117
44	1 25.845	1 35.674	1 45.504	1 55.333	2 5.163	2 14.993	2 24.822	2 34.652	44	.120
45	1 26.009	1 35.838	1 45.668	1 55.497	2 5.327	2 15.156	2 24.986	2 34.816	45	.123
46	1 26.172	1 36.002	1 45.832	1 55.661	2 5.491	2 15.320	2 25.150	2 34.979	46	.126
47	1 26.336	1 36.166	1 45.995	1 55.825	2 5.655	2 15.484	2 25.314	2 35.143	47	.128
48	1 26.500	1 36.330	1 46.159	1 55.989	2 5.818	2 15.648	2 25.477	2 35.307	48	.131
49	1 26.664	1 36.493	1 46.323	1 56.153	2 5.982	2 15.812	2 25.641	2 35.471	49	.134
50	1 26.828	1 36.657	1 46.487	1 56.316	2 6.146	2 15.976	2 25.805	2 35.635	50	.137
51	1 26.992	1 36.821	1 46.651	1 56.480	2 6.310	2 16.139	2 25.969	2 35.798	51	.139
52	1 27.156	1 36.985	1 46.815	1 56.644	2 6.474	2 16.303	2 26.133	2 35.962	52	.142
53	1 27.319	1 37.149	1 46.978	1 56.808	2 6.637	2 16.467	2 26.297	2 36.126	53	.145
54	1 27.483	1 37.313	1 47.142	1 56.972	2 6.801	2 16.631	2 26.460	2 36.290	54	.147
55	1 27.647	1 37.476	1 47.306	1 57.136	2 6.965	2 16.795	2 26.624	2 36.454	55	.150
56	1 27.811	1 37.640	1 47.470	1 57.299	2 7.129	2 16.959	2 26.788	2 36.618	56	.153
57	1 27.975	1 37.804	1 47.634	1 57.463	2 7.293	2 17.122	2 26.952	2 36.781	57	.156
58	1 28.138	1 37.968	1 47.797	1 57.627	2 7.457	2 17.286	2 27.116	2 36.945	58	.158
59	1 28.302	1 38.132	1 47.961	1 57.791	2 7.620	2 17.450	2 27.280	2 37.109	59	0.161

TABLE 8.

Sidereal into Mean Solar Time.

To be subtracted from a sidereal time interval.

Sidereal.	16^{h}	17^{h}	18^{h}	19^{h}	20^{h}	21^{h}	22^{h}	23^{h}	For seconds.	
m.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	s.	s.
0	2 37.273	2 47.102	2 56.932	3 6.762	3 16.591	3 26.421	3 36.250	3 46.080		
1	2 37.437	2 47.266	2 57.096	3 6.925	3 16.755	3 26.585	3 36.414	3 46.244	1	0.003
2	2 37.601	2 47.430	2 57.260	3 7.089	3 16.919	3 26.748	3 36.578	3 46.407	2	.005
3	2 37.764	2 47.594	2 57.424	3 7.253	3 17.083	3 26.912	3 36.742	3 46.571	3	.008
4	2 37.928	2 47.758	2 57.587	3 7.417	3 17.246	3 27.076	3 36.906	3 46.735	4	.011
5	2 38.092	2 47.922	2 57.751	3 7.581	3 17.410	3 27.240	3 37.069	3 46.899	5	.014
6	2 38.256	2 48.085	2 57.915	3 7.745	3 17.574	3 27.404	3 37.233	3 47.063	6	.016
7	2 38.420	2 48.249	2 58.079	3 7.908	3 17.738	3 27.568	3 37.397	3 47.227	7	.019
8	2 38.584	2 48.413	2 58.243	3 8.072	3 17.902	3 27.731	3 37.561	3 47.390	8	.022
9	2 38.747	2 48.577	2 58.406	3 8.236	3 18.066	3 27.895	3 37.725	3 47.554	9	.025
10	2 38.911	2 48.741	2 58.570	3 8.400	3 18.229	3 28.059	3 37.889	3 47.718	10	.027
11	2 39.075	2 48.905	2 58.734	3 8.564	3 18.393	3 28.223	3 38.052	3 47.882	11	.030
12	2 39.239	2 49.068	2 58.898	3 8.728	3 18.557	3 28.387	3 38.216	3 48.046	12	.033
13	2 39.403	2 49.232	2 59.062	3 8.891	3 18.721	3 28.550	3 38.380	3 48.210	13	.035
14	2 39.566	2 49.396	2 59.226	3 9.055	3 18.885	3 28.714	3 38.544	3 48.373	14	.038
15	2 39.730	2 49.560	2 59.389	3 9.219	3 19.049	3 28.878	3 38.708	3 48.537	15	.041
16	2 39.894	2 49.724	2 59.553	3 9.383	3 19.212	3 29.042	3 38.871	3 48.701	16	.044
17	2 40.058	2 49.888	2 59.717	3 9.547	3 19.376	3 29.206	3 39.035	3 48.865	17	.046
18	2 40.222	2 50.051	2 59.881	3 9.710	3 19.540	3 29.370	3 39.199	3 49.029	18	.049
19	2 40.386	2 50.215	3 0.045	3 9.874	3 19.704	3 29.533	3 39.363	3 49.193	19	.052
20	2 40.549	2 50.379	3 0.209	3 10.038	3 19.868	3 29.697	3 39.527	3 49.356	20	.055
21	2 40.713	2 50.543	3 0.372	3 10.202	3 20.032	3 29.861	3 39.691	3 49.520	21	.057
22	2 40.877	2 50.707	3 0.536	3 10.366	3 20.195	3 30.025	3 39.854	3 49.684	22	.060
23	2 41.041	2 50.870	3 0.700	3 10.530	3 20.359	3 30.189	3 40.018	3 49.848	23	.063
24	2 41.205	2 51.034	3 0.864	3 10.693	3 20.523	3 30.353	3 40.182	3 50.012	24	.066
25	2 41.369	2 51.198	3 1.028	3 10.857	3 20.687	3 30.516	3 40.346	3 50.175	25	.068
26	2 41.532	2 51.362	3 1.192	3 11.021	3 20.851	3 30.680	3 40.510	3 50.339	26	.071
27	2 41.696	2 51.526	3 1.355	3 11.185	3 21.014	3 30.844	3 40.674	3 50.503	27	.074
28	2 41.860	2 51.690	3 1.519	3 11.349	3 21.178	3 31.008	3 40.837	3 50.667	28	.076
29	2 42.024	2 51.853	3 1.683	3 11.513	3 21.342	3 31.172	3 41.001	3 50.831	29	.079
30	2 42.188	2 52.017	3 1.847	3 11.676	3 21.506	3 31.336	3 41.165	3 50.995	30	.082
31	2 42.352	2 52.181	3 2.011	3 11.840	3 21.670	3 31.499	3 41.329	3 51.158	31	.085
32	2 42.515	2 52.345	3 2.174	3 12.004	3 21.834	3 31.663	3 41.493	3 51.322	32	.087
33	2 42.679	2 52.509	3 2.338	3 12.168	3 21.997	3 31.827	3 41.657	3 51.486	33	.090
34	2 42.843	2 52.673	3 2.502	3 12.332	3 22.161	3 31.991	3 41.820	3 51.650	34	.093
35	2 43.007	2 52.836	3 2.666	3 12.496	3 22.325	3 32.155	3 41.984	3 51.814	35	.096
36	2 43.171	2 53.000	3 2.830	3 12.659	3 22.489	3 32.318	3 42.148	3 51.978	36	.098
37	2 43.334	2 53.164	3 2.994	3 12.823	3 22.653	3 32.482	3 42.312	3 52.141	37	.101
38	2 43.498	2 53.328	3 3.157	3 12.987	3 22.817	3 32.646	3 42.476	3 52.305	38	.104
39	2 43.662	2 53.492	3 3.321	3 13.151	3 22.980	3 32.810	3 42.639	3 52.469	39	.106
40	2 43.826	2 53.656	3 3.485	3 13.315	3 23.144	3 32.974	3 42.803	3 52.633	40	.109
41	2 43.990	2 53.819	3 3.649	3 13.478	3 23.308	3 33.138	3 42.967	3 52.797	41	.112
42	2 44.154	2 53.983	3 3.813	3 13.642	3 23.472	3 33.301	3 43.131	3 52.961	42	.115
43	2 44.317	2 54.147	3 3.977	3 13.806	3 23.636	3 33.465	3 43.295	3 53.124	43	.117
44	2 44.481	2 54.311	3 4.140	3 13.970	3 23.800	3 33.629	3 43.459	3 53.288	44	.120
45	2 44.645	2 54.475	3 4.304	3 14.134	3 23.963	3 33.793	3 43.622	3 53.452	45	.123
46	2 44.809	2 54.638	3 4.468	3 14.298	3 24.127	3 33.957	3 43.786	3 53.616	46	.126
47	2 44.973	2 54.802	3 4.632	3 14.461	3 24.291	3 34.121	3 43.950	3 53.780	47	.128
48	2 45.137	2 54.966	3 4.796	3 14.625	3 24.455	3 34.284	3 44.114	3 53.943	48	.131
49	2 45.300	2 55.130	3 4.960	3 14.789	3 24.619	3 34.448	3 44.278	3 54.107	49	.134
50	2 45.464	2 55.294	3 5.123	3 14.953	3 24.782	3 34.612	3 44.442	3 54.271	50	.137
51	2 45.628	2 55.458	3 5.287	3 15.117	3 24.946	3 34.776	3 44.605	3 54.435	51	.139
52	2 45.792	2 55.621	3 5.451	3 15.281	3 25.110	3 34.940	3 44.769	3 54.599	52	.142
53	2 45.956	2 55.785	3 5.615	3 15.444	3 25.274	3 35.104	3 44.933	3 54.763	53	.145
54	2 46.120	2 55.949	3 5.779	3 15.608	3 25.438	3 35.267	3 45.097	3 54.926	54	.147
55	2 46.283	2 56.113	3 5.942	3 15.772	3 25.602	3 35.431	3 45.261	3 55.090	55	.150
56	2 46.447	2 56.277	3 6.106	3 15.936	3 25.765	3 35.595	3 45.425	3 55.254	56	.153
57	2 46.611	2 56.441	3 6.270	3 16.100	3 25.929	3 35.759	3 45.588	3 55.418	57	.156
58	2 46.755	2 56.604	3 6.434	3 16.264	3 26.093	3 35.923	3 45.752	3 55.582	58	.158
59	2 46.939	2 56.768	3 6.598	3 16.427	3 26.257	3 36.086	3 45.916	3 55.746	59	0.161

TABLE 9.

Mean Solar into Sidereal Time.

To be added to a mean time interval.

Mean.	0h	1h	2h	3h	4h	5h	6h	7h	For seconds.	
m.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	s.	s.
0	0 0.000	0 9.856	0 19.713	0 29.569	0 39.426	0 49.282	0 59.139	1 8.995		
1	0 0.164	0 10.021	0 19.877	0 29.734	0 39.590	0 49.447	0 59.303	1 9.160	1	0.003
2	0 0.329	0 10.185	0 20.041	0 29.898	0 39.754	0 49.611	0 59.467	1 9.324	2	.005
3	0 0.493	0 10.349	0 20.206	0 30.062	0 39.919	0 49.775	0 59.632	1 9.488	3	.008
4	0 0.657	0 10.514	0 20.370	0 30.227	0 40.083	0 49.939	0 59.796	1 9.652	4	.011
5	0 0.821	0 10.678	0 20.534	0 30.391	0 40.247	0 50.104	0 59.960	1 9.817	5	.014
6	0 0.986	0 10.842	0 20.699	0 30.555	0 40.412	0 50.268	1 0.124	1 9.981	6	.016
7	0 1.150	0 11.006	0 20.863	0 30.719	0 40.576	0 50.432	1 0.289	1 10.145	7	.019
8	0 1.314	0 11.171	0 21.027	0 30.884	0 40.740	0 50.597	1 0.453	1 10.310	8	.022
9	0 1.478	0 11.335	0 21.191	0 31.048	0 40.904	0 50.761	1 0.617	1 10.474	9	.025
10	0 1.643	0 11.499	0 21.356	0 31.212	0 41.069	0 50.925	1 0.782	1 10.638	10	.027
11	0 1.807	0 11.663	0 21.520	0 31.376	0 41.233	0 51.089	1 0.946	1 10.802	11	.030
12	0 1.971	0 11.828	0 21.684	0 31.541	0 41.397	0 51.254	1 1.110	1 10.967	12	.033
13	0 2.136	0 11.992	0 21.849	0 31.705	0 41.561	0 51.418	1 1.274	1 11.131	13	.036
14	0 2.300	0 12.156	0 22.013	0 31.869	0 41.726	0 51.582	1 1.439	1 11.295	14	.038
15	0 2.464	0 12.321	0 22.177	0 32.034	0 41.890	0 51.746	1 1.603	1 11.459	15	.041
16	0 2.628	0 12.485	0 22.341	0 32.198	0 42.054	0 51.911	1 1.767	1 11.624	16	.044
17	0 2.793	0 12.649	0 22.506	0 32.362	0 42.219	0 52.075	1 1.932	1 11.788	17	.047
18	0 2.957	0 12.813	0 22.670	0 32.526	0 42.383	0 52.239	1 2.096	1 11.952	18	.049
19	0 3.121	0 12.978	0 22.834	0 32.691	0 42.547	0 52.404	1 2.260	1 12.117	19	.052
20	0 3.285	0 13.142	0 22.998	0 32.855	0 42.711	0 52.568	1 2.424	1 12.281	20	.055
21	0 3.450	0 13.306	0 23.163	0 33.019	0 42.876	0 52.732	1 2.589	1 12.445	21	.057
22	0 3.614	0 13.471	0 23.327	0 33.183	0 43.040	0 52.896	1 2.753	1 12.609	22	.060
23	0 3.778	0 13.635	0 23.491	0 33.348	0 43.204	0 53.061	1 2.917	1 12.774	23	.063
24	0 3.943	0 13.799	0 23.656	0 33.512	0 43.368	0 53.225	1 3.081	1 12.938	24	.066
25	0 4.107	0 13.963	0 23.820	0 33.676	0 43.533	0 53.389	1 3.246	1 13.102	25	.068
26	0 4.271	0 14.128	0 23.984	0 33.841	0 43.697	0 53.554	1 3.410	1 13.266	26	.071
27	0 4.435	0 14.292	0 24.148	0 34.005	0 43.861	0 53.718	1 3.574	1 13.431	27	.074
28	0 4.600	0 14.456	0 24.313	0 34.169	0 44.026	0 53.882	1 3.739	1 13.595	28	.077
29	0 4.764	0 14.620	0 24.477	0 34.333	0 44.190	0 54.046	1 3.903	1 13.759	29	.079
30	0 4.928	0 14.785	0 24.641	0 34.498	0 44.354	0 54.211	1 4.067	1 13.924	30	.082
31	0 5.093	0 14.949	0 24.805	0 34.662	0 44.518	0 54.375	1 4.231	1 14.088	31	.085
32	0 5.257	0 15.113	0 24.970	0 34.826	0 44.683	0 54.539	1 4.396	1 14.252	32	.088
33	0 5.421	0 15.278	0 25.134	0 34.990	0 44.847	0 54.703	1 4.560	1 14.416	33	.090
34	0 5.585	0 15.442	0 25.298	0 35.155	0 45.011	0 54.868	1 4.724	1 14.581	34	.093
35	0 5.750	0 15.606	0 25.463	0 35.319	0 45.176	0 55.032	1 4.888	1 14.745	35	.096
36	0 5.914	0 15.770	0 25.627	0 35.483	0 45.340	0 55.196	1 5.053	1 14.909	36	.099
37	0 6.078	0 15.935	0 25.791	0 35.648	0 45.504	0 55.361	1 5.217	1 15.073	37	.101
38	0 6.242	0 16.099	0 25.955	0 35.812	0 45.668	0 55.525	1 5.381	1 15.238	38	.104
39	0 6.407	0 16.263	0 26.120	0 35.976	0 45.833	0 55.689	1 5.546	1 15.402	39	.107
40	0 6.571	0 16.427	0 26.284	0 36.140	0 45.997	0 55.853	1 5.710	1 15.566	40	.110
41	0 6.735	0 16.592	0 26.448	0 36.305	0 46.161	0 56.018	1 5.874	1 15.731	41	.112
42	0 6.900	0 16.756	0 26.612	0 36.469	0 46.325	0 56.182	1 6.038	1 15.895	42	.115
43	0 7.064	0 16.920	0 26.777	0 36.633	0 46.490	0 56.346	1 6.203	1 16.059	43	.118
44	0 7.228	0 17.085	0 26.941	0 36.798	0 46.654	0 56.510	1 6.367	1 16.223	44	.120
45	0 7.392	0 17.249	0 27.105	0 36.962	0 46.818	0 56.675	1 6.531	1 16.388	45	.123
46	0 7.557	0 17.413	0 27.270	0 37.126	0 46.983	0 56.839	1 6.695	1 16.552	46	.126
47	0 7.721	0 17.577	0 27.434	0 37.290	0 47.147	0 57.003	1 6.860	1 16.716	47	.129
48	0 7.885	0 17.742	0 27.598	0 37.455	0 47.311	0 57.168	1 7.024	1 16.881	48	.131
49	0 8.049	0 17.906	0 27.762	0 37.619	0 47.475	0 57.332	1 7.188	1 17.045	49	.134
50	0 8.214	0 18.070	0 27.927	0 37.783	0 47.640	0 57.496	1 7.353	1 17.209	50	.137
51	0 8.378	0 18.234	0 28.091	0 37.947	0 47.804	0 57.660	1 7.517	1 17.373	51	.140
52	0 8.542	0 18.399	0 28.255	0 38.112	0 47.968	0 57.825	1 7.681	1 17.538	52	.142
53	0 8.707	0 18.563	0 28.420	0 38.276	0 48.132	0 57.989	1 7.845	1 17.702	53	.145
54	0 8.871	0 18.727	0 28.584	0 38.440	0 48.297	0 58.153	1 8.010	1 17.866	54	.148
55	0 9.035	0 18.892	0 28.748	0 38.605	0 48.461	0 58.317	1 8.174	1 18.030	55	.151
56	0 9.199	0 19.056	0 28.912	0 38.769	0 48.625	0 58.482	1 8.338	1 18.195	56	.153
57	0 9.364	0 19.220	0 29.077	0 38.933	0 48.790	0 58.646	1 8.502	1 18.359	57	.156
58	0 9.528	0 19.384	0 29.241	0 39.097	0 48.954	0 58.810	1 8.667	1 18.523	58	.159
59	0 9.692	0 19.549	0 29.405	0 39.262	0 49.118	0 58.975	1 8.831	1 18.688	59	0.162

TABLE 9.

Mean Solar into Sidereal Time.

To be added to a mean time interval.

Mean.	8^h	9^h	10^h	11^h	12^h	13^h	14^h	15^h	For seconds.	
m.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	s.	s.
0	1 18.852	1 28.708	1 38.565	1 48.421	1 58.278	2 8.134	2 17.991	2 27.847		
1	1 19.016	1 28.873	1 38.729	1 48.585	1 58.442	2 8.298	2 18.155	2 28.011	1	0.003
2	1 19.180	1 29.037	1 38.893	1 48.750	1 58.606	2 8.463	2 18.319	2 28.176	2	.005
3	1 19.345	1 29.201	1 39.058	1 48.914	1 58.771	2 8.627	2 18.483	2 28.340	3	.008
4	1 19.509	1 29.365	1 39.222	1 49.078	1 58.935	2 8.791	2 18.648	2 28.504	4	.011
5	1 19.673	1 29.530	1 39.386	1 49.243	1 59.099	2 8.956	2 18.812	2 28.668	5	.014
6	1 19.837	1 29.694	1 39.550	1 49.407	1 59.263	2 9.120	2 18.976	2 28.833	6	.016
7	1 20.002	1 29.858	1 39.715	1 49.571	1 59.428	2 9.284	2 19.141	2 28.997	7	.019
8	1 20.166	1 30.022	1 39.879	1 49.735	1 59.592	2 9.448	2 19.305	2 29.161	8	.022
9	1 20.330	1 30.187	1 40.043	1 49.900	1 59.756	2 9.613	2 19.469	2 29.326	9	.025
10	1 20.495	1 30.351	1 40.207	1 50.064	1 59.920	2 9.777	2 19.633	2 29.490	10	.027
11	1 20.659	1 30.515	1 40.372	1 50.228	2 0.085	2 9.941	2 19.798	2 29.654	11	.030
12	1 20.823	1 30.680	1 40.536	1 50.393	2 0.249	2 10.105	2 19.962	2 29.818	12	.033
13	1 20.987	1 30.844	1 40.700	1 50.557	2 0.413	2 10.270	2 20.126	2 29.983	13	.036
14	1 21.152	1 31.008	1 40.865	1 50.721	2 0.578	2 10.434	2 20.290	2 30.147	14	.038
15	1 21.316	1 31.172	1 41.029	1 50.885	2 0.742	2 10.598	2 20.455	2 30.311	15	.041
16	1 21.480	1 31.337	1 41.193	1 51.050	2 0.906	2 10.763	2 20.619	2 30.476	16	.044
17	1 21.644	1 31.501	1 41.357	1 51.214	2 1.070	2 10.927	2 20.783	2 30.640	17	.047
18	1 21.809	1 31.665	1 41.522	1 51.378	2 1.235	2 11.091	2 20.948	2 30.804	18	.049
19	1 21.973	1 31.829	1 41.686	1 51.542	2 1.399	2 11.255	2 21.112	2 30.968	19	.052
20	1 22.137	1 31.994	1 41.850	1 51.707	2 1.563	2 11.420	2 21.276	2 31.133	20	.055
21	1 22.302	1 32.158	1 42.015	1 51.871	2 1.727	2 11.584	2 21.440	2 31.297	21	.057
22	1 22.466	1 32.322	1 42.179	1 52.035	2 1.892	2 11.748	2 21.605	2 31.461	22	.060
23	1 22.630	1 32.487	1 42.343	1 52.200	2 2.056	2 11.912	2 21.769	2 31.625	23	.063
24	1 22.794	1 32.651	1 42.507	1 52.364	2 2.220	2 12.077	2 21.933	2 31.790	24	.066
25	1 22.959	1 32.815	1 42.672	1 52.528	2 2.385	2 12.241	2 22.098	2 31.954	25	.068
26	1 23.123	1 32.979	1 42.836	1 52.692	2 2.549	2 12.405	2 22.262	2 32.118	26	.071
27	1 23.287	1 33.144	1 43.000	1 52.857	2 2.713	2 12.570	2 22.426	2 32.283	27	.074
28	1 23.451	1 33.308	1 43.164	1 53.021	2 2.877	2 12.734	2 22.590	2 32.447	28	.077
29	1 23.616	1 33.472	1 43.329	1 53.185	2 3.042	2 12.898	2 22.755	2 32.611	29	.079
30	1 23.780	1 33.637	1 43.493	1 53.349	2 3.206	2 13.062	2 22.919	2 32.775	30	.082
31	1 23.944	1 33.801	1 43.657	1 53.514	2 3.370	2 13.227	2 23.083	2 32.940	31	.085
32	1 24.109	1 33.965	1 43.822	1 53.678	2 3.534	2 13.391	2 23.247	2 33.104	32	.088
33	1 24.273	1 34.129	1 43.986	1 53.842	2 3.699	2 13.555	2 23.412	2 33.268	33	.090
34	1 24.437	1 34.294	1 44.150	1 54.007	2 3.863	2 13.720	2 23.576	2 33.432	34	.093
35	1 24.601	1 34.458	1 44.314	1 54.171	2 4.027	2 13.884	2 23.740	2 33.597	35	.096
36	1 24.766	1 34.622	1 44.479	1 54.335	2 4.192	2 14.048	2 23.905	2 33.761	36	.099
37	1 24.930	1 34.786	1 44.643	1 54.499	2 4.356	2 14.212	2 24.069	2 33.925	37	.101
38	1 25.094	1 34.951	1 44.807	1 54.664	2 4.520	2 14.377	2 24.233	2 34.090	38	.104
39	1 25.259	1 35.115	1 44.971	1 54.828	2 4.684	2 14.541	2 24.397	2 34.254	39	.107
40	1 25.423	1 35.279	1 45.136	1 54.992	2 4.849	2 14.705	2 24.562	2 34.418	40	.110
41	1 25.587	1 35.444	1 45.300	1 55.156	2 5.013	2 14.869	2 24.726	2 34.582	41	.112
42	1 25.751	1 35.608	1 45.464	1 55.321	2 5.177	2 15.034	2 24.890	2 34.747	42	.115
43	1 25.916	1 35.772	1 45.629	1 55.485	2 5.342	2 15.198	2 25.054	2 34.911	43	.118
44	1 26.080	1 35.936	1 45.793	1 55.649	2 5.506	2 15.362	2 25.219	2 35.075	44	.120
45	1 26.244	1 36.101	1 45.957	1 55.814	2 5.670	2 15.527	2 25.383	2 35.239	45	.123
46	1 26.408	1 36.265	1 46.121	1 55.978	2 5.834	2 15.691	2 25.547	2 35.404	46	.126
47	1 26.573	1 36.429	1 46.286	1 56.142	2 5.999	2 15.855	2 25.712	2 35.568	47	.129
48	1 26.737	1 36.593	1 46.450	1 56.306	2 6.163	2 16.019	2 25.876	2 35.732	48	.131
49	1 26.901	1 36.758	1 46.614	1 56.471	2 6.327	2 16.184	2 26.040	2 35.897	49	.134
50	1 27.066	1 36.922	1 46.778	1 56.635	2 6.491	2 16.348	2 26.204	2 36.061	50	.137
51	1 27.230	1 37.086	1 46.943	1 56.799	2 6.656	2 16.512	2 26.369	2 36.225	51	.140
52	1 27.394	1 37.251	1 47.107	1 56.964	2 6.820	2 16.676	2 26.533	2 36.389	52	.142
53	1 27.558	1 37.415	1 47.271	1 57.128	2 6.984	2 16.841	2 26.697	2 36.554	53	.145
54	1 27.723	1 37.579	1 47.436	1 57.292	2 7.149	2 17.005	2 26.861	2 36.718	54	.148
55	1 27.887	1 37.743	1 47.600	1 57.456	2 7.313	2 17.169	2 27.026	2 36.882	55	.151
56	1 28.051	1 37.908	1 47.764	1 57.621	2 7.477	2 17.334	2 27.190	2 37.047	56	.153
57	1 28.215	1 38.072	1 47.928	1 57.785	2 7.641	2 17.498	2 27.354	2 37.211	57	.156
58	1 28.380	1 38.236	1 48.093	1 57.949	2 7.806	2 17.662	2 27.519	2 37.375	58	.159
59	1 28.544	1 38.400	1 48.257	1 58.113	2 7.970	2 17.826	2 27.683	2 37.539	59	0.162

TABLE 9.

Mean Solar into Sidereal time.

To be added to a mean time interval.

Mean.	16^{h}	17^{h}	18^{h}	19^{h}	20^{h}	21^{h}	22^{h}	23^{h}	For seconds.	
m.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	s.	s.
0	2 37.704	2 47.560	2 57.417	3 7.273	3 17.129	3 26.986	3 36.842	3 46.699		
1	2 37.868	2 47.724	2 57.581	3 7.437	3 17.294	3 27.150	3 37.007	3 46.863	1	0.003
2	2 38.032	2 47.889	2 57.745	3 7.602	3 17.458	3 27.315	3 37.171	3 47.027	2	.005
3	2 38.196	2 48.053	2 57.909	3 7.766	3 17.622	3 27.479	3 37.335	3 47.192	3	.008
4	2 38.361	2 48.217	2 58.074	3 7.930	3 17.787	3 27.643	3 37.500	3 47.356	4	.011
5	2 38.525	2 48.381	2 58.238	3 8.094	3 17.951	3 27.807	3 37.664	3 47.520	5	.014
6	2 38.689	2 48.546	2 58.402	3 8.259	3 18.115	3 27.972	3 37.828	3 47.685	6	.016
7	2 38.854	2 48.710	2 58.566	3 8.423	3 18.279	3 28.136	3 37.992	3 47.849	7	.019
8	2 39.018	2 48.874	2 58.731	3 8.587	3 18.444	3 28.300	3 38.157	3 48.013	8	.022
9	2 39.182	2 49.039	2 58.895	3 8.751	3 18.608	3 28.464	3 38.321	3 48.177	9	.025
10	2 39.346	2 49.203	2 59.059	3 8.916	3 18.772	3 28.629	3 38.485	3 48.342	10	.027
11	2 39.511	2 49.367	2 59.224	3 9.080	3 18.937	3 28.793	3 38.649	3 48.506	11	.030
12	2 39.675	2 49.531	2 59.388	3 9.244	3 19.101	3 28.957	3 38.814	3 48.670	12	.033
13	2 39.839	2 49.696	2 59.552	3 9.409	3 19.265	3 29.122	3 38.978	3 48.834	13	.036
14	2 40.003	2 49.860	2 59.716	3 9.573	3 19.429	3 29.286	3 39.142	3 48.999	14	.038
15	2 40.168	2 50.024	2 59.881	3 9.737	3 19.594	3 29.450	3 39.307	3 49.163	15	.041
16	2 40.332	2 50.188	3 0.045	3 9.901	3 19.758	3 29.614	3 39.471	3 49.327	16	.044
17	2 40.496	2 50.353	3 0.209	3 10.066	3 19.922	3 29.779	3 39.635	3 49.492	17	.047
18	2 40.661	2 50.517	3 0.373	3 10.230	3 20.086	3 29.943	3 39.799	3 49.656	18	.049
19	2 40.825	2 50.681	3 0.538	3 10.394	3 20.251	3 30.107	3 39.964	3 49.820	19	.052
20	2 40.989	2 50.846	3 0.702	3 10.559	3 20.415	3 30.271	3 40.128	3 49.984	20	.055
21	2 41.153	2 51.010	3 0.866	3 10.723	3 20.579	3 30.436	3 40.292	3 50.149	21	.057
22	2 41.318	2 51.174	3 1.031	3 10.887	3 20.744	3 30.600	3 40.456	3 50.313	22	.060
23	2 41.482	2 51.338	3 1.195	3 11.051	3 20.908	3 30.764	3 40.621	3 50.477	23	.063
24	2 41.646	2 51.503	3 1.359	3 11.216	3 21.072	3 30.929	3 40.785	3 50.642	24	.066
25	2 41.810	2 51.667	3 1.523	3 11.380	3 21.236	3 31.093	3 40.949	3 50.806	25	.068
26	2 41.975	2 51.831	3 1.688	3 11.544	3 21.401	3 31.257	3 41.114	3 50.970	26	.071
27	2 42.139	2 51.995	3 1.852	3 11.708	3 21.565	3 31.421	3 41.278	3 51.134	27	.074
28	2 42.303	2 52.160	3 2.016	3 11.873	3 21.729	3 31.586	3 41.442	3 51.299	28	.077
29	2 42.468	2 52.324	3 2.181	3 12.037	3 21.893	3 31.750	3 41.606	3 51.463	29	.079
30	2 42.632	2 52.488	3 2.345	3 12.201	3 22.058	3 31.914	3 41.771	3 51.627	30	.082
31	2 42.796	2 52.653	3 2.509	3 12.366	3 22.222	3 32.078	3 41.935	3 51.791	31	.085
32	2 42.960	2 52.817	3 2.673	3 12.530	3 22.386	3 32.243	3 42.099	3 51.956	32	.088
33	2 43.125	2 52.981	3 2.838	3 12.694	3 22.551	3 32.407	3 42.264	3 52.120	33	.090
34	2 43.289	2 53.145	3 3.002	3 12.858	3 22.715	3 32.571	3 42.428	3 52.284	34	.093
35	2 43.453	2 53.310	3 3.166	3 13.023	3 22.879	3 32.736	3 42.592	3 52.449	35	.096
36	2 43.617	2 53.474	3 3.330	3 13.187	3 23.043	3 32.900	3 42.756	3 52.613	36	.099
37	2 43.782	2 53.638	3 3.495	3 13.351	3 23.208	3 33.064	3 42.921	3 52.777	37	.101
38	2 43.946	2 53.803	3 3.659	3 13.515	3 23.372	3 33.228	3 43.085	3 52.941	38	.104
39	2 44.110	2 53.967	3 3.823	3 13.680	3 23.536	3 33.393	3 43.249	3 53.106	39	.107
40	2 44.275	2 54.131	3 3.988	3 13.844	3 23.700	3 33.557	3 43.413	3 53.270	40	.110
41	2 44.439	2 54.295	3 4.152	3 14.008	3 23.865	3 33.721	3 43.578	3 53.434	41	.112
42	2 44.603	2 54.460	3 4.316	3 14.173	3 24.029	3 33.886	3 43.742	3 58.598	42	.115
43	2 44.767	2 54.624	3 4.480	3 14.337	3 24.193	3 34.050	3 43.906	3 53.763	43	.118
44	2 44.932	2 54.788	3 4.645	3 14.501	3 24.358	3 34.214	3 44.071	3 53.927	44	.120
45	2 45.096	2 54.952	3 4.809	3 14.665	3 24.522	3 34.378	3 44.235	3 54.091	45	.123
46	2 45.260	2 55.117	3 4.973	3 14.830	3 24.686	3 34.543	3 44.399	3 54.256	46	.126
47	2 45.425	2 55.281	3 5.137	3 14.994	3 24.850	3 34.707	3 44.563	3 54.420	47	.129
48	2 45.589	2 55.445	3 5.302	3 15.158	3 25.015	3 34.871	3 44.728	3 54.584	48	.131
49	2 45.753	2 55.610	3 5.466	3 15.322	3 25.179	3 35.035	3 44.892	3 54.748	49	.134
50	2 45.917	2 55.774	3 5.630	3 15.487	3 25.343	3 35.200	3 45.056	3 54.913	50	.137
51	2 46.082	2 55.938	3 5.795	3 15.651	3 25.508	3 35.364	3 45.220	3 55.077	51	.140
52	2 46.246	2 56.102	3 5.959	3 15.815	3 25.672	3 35.528	3 45.385	3 55.241	52	.142
53	2 46.410	2 56.267	3 6.123	3 15.980	3 25.836	3 35.693	3 45.549	3 55.405	53	.145
54	2 46.574	2 56.431	3 6.287	3 16.144	3 26.000	3 35.857	3 45.713	3 55.570	54	.148
55	2 46.739	2 56.595	3 6.452	3 16.308	3 26.165	3 36.021	3 45.878	3 55.734	55	.151
56	2 46.903	2 56.759	3 6.616	3 16.472	3 26.329	3 36.185	3 46.042	3 55.898	56	.153
57	2 47.067	2 56.924	3 6.780	3 16.637	3 26.493	3 36.350	3 46.206	3 56.063	57	.156
58	2 47.232	2 57.088	3 6.944	3 16.801	3 26.657	3 36.514	3 46.370	3 56.227	58	.159
59	2 47.396	2 57.252	3 7.109	3 16.965	3 26.822	3 36.678	3 46.535	3 56.391	59	0.162

TABLE 10.

Mean Time of Sun's Visible Rising and Setting.

North Latitude: 0° to 20°—March 21 to June 22.

[R—Local mean time of sun's visible rising. S—Local mean time of sun's visible setting.]

Lat. N.	Approx. date.	MARCH.					APRIL.										MAY.							JUNE.			Approx. date.	Lat. N.
		21	23	26	28	31	3	5	8	11	13	16	19	22	25	28	1	5	8	12	16	21	26	1	10	22		
	Dec. N.	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	13°	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	23° 27′	Dec. N.	
°		h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.		°
0	R.	6 04	6 03	6 02	6 01	6 00	6 00	5 59	5 58	5 57	5 57	5 56	5 55	5 55	5 54	5 53	5 53	5 53	5 52	5 52	5 52	5 52	5 53	5 54	5 55	5 57	R.	0
	S.	6 11	6 11	6 10	6 09	6 08	6 08	6 07	6 06	6 05	6 05	6 04	6 03	6 03	6 02	6 01	6 01	6 01	6 00	6 00	6 00	6 00	6 01	6 02	6 03	6 05	S.	
1	R.	6 04	6 03	6 02	6 01	6 00	6 00	5 59	5 58	5 57	5 56	5 55	5 55	5 54	5 53	5 52	5 52	5 52	5 51	5 51	5 51	5 51	5 51	5 52	5 54	5 56	R.	1
	S.	6 11	6 11	6 10	6 09	6 08	6 08	6 07	6 06	6 05	6 05	6 04	6 04	6 03	6 03	6 02	6 02	6 02	6 01	6 01	6 01	6 02	6 02	6 03	6 05	6 07	S.	
2	R.	6 04	6 03	6 02	6 01	6 00	6 00	5 59	5 58	5 57	5 56	5 55	5 54	5 53	5 52	5 51	5 51	5 51	5 50	5 50	5 50	5 49	5 50	5 51	5 52	5 54	R.	2
	S.	6 11	6 11	6 10	6 09	6 08	6 08	6 07	6 07	6 06	6 05	6 05	6 04	6 04	6 04	6 03	6 03	6 03	6 02	6 02	6 03	6 03	6 04	6 05	6 06	6 08	S.	
3	R.	6 04	6 03	6 02	6 01	6 00	5 59	5 58	5 57	5 56	5 55	5 54	5 53	5 52	5 51	5 50	5 50	5 50	5 49	5 49	5 48	5 48	5 48	5 49	5 50	5 52	R.	3
	S.	6 11	6 11	6 10	6 09	6 09	6 08	6 07	6 07	6 06	6 06	6 06	6 05	6 05	6 05	6 04	6 04	6 04	6 03	6 04	6 04	6 05	6 05	6 06	6 08	6 10	S.	
4	R.	6 04	6 03	6 02	6 01	6 00	5 59	5 58	5 57	5 56	5 55	5 54	5 53	5 52	5 50	5 49	5 49	5 49	5 48	5 47	5 47	5 46	5 47	5 48	5 49	5 51	R.	4
	S.	6 11	6 11	6 10	6 09	6 09	6 08	6 08	6 08	6 07	6 07	6 06	6 06	6 06	6 06	6 05	6 05	6 05	6 05	6 06	6 06	6 06	6 07	6 08	6 10	6 12	S.	
5	R.	6 04	6 03	6 02	6 01	6 00	5 59	5 57	5 56	5 55	5 54	5 53	5 52	5 51	5 49	5 48	5 48	5 47	5 46	5 46	5 45	5 45	5 45	5 46	5 47	5 49	R.	5
	S.	6 11	6 11	6 10	6 10	6 09	6 09	6 08	6 08	6 08	6 08	6 07	6 07	6 07	6 06	6 06	6 06	6 06	6 06	6 07	6 07	6 08	6 08	6 09	6 11	6 13	S.	
6	R.	6 03	6 02	6 01	6 01	5 59	5 58	5 57	5 55	5 54	5 53	5 52	5 51	5 50	5 49	5 47	5 47	5 46	5 45	5 45	5 44	5 43	5 44	5 45	5 46	5 47	R.	6
	S.	6 11	6 11	6 10	6 10	6 09	6 09	6 09	6 08	6 08	6 08	6 08	6 07	6 07	6 07	6 07	6 07	6 07	6 07	6 08	6 08	6 09	6 10	6 11	6 13	6 15	S.	
7	R.	6 03	6 02	6 01	6 00	5 59	5 58	5 56	5 55	5 54	5 53	5 51	5 50	5 49	5 48	5 46	5 46	5 45	5 44	5 43	5 43	5 42	5 42	5 43	5 44	5 46	R.	7
	S.	6 11	6 11	6 10	6 10	6 10	6 10	6 09	6 09	6 09	6 09	6 08	6 08	6 08	6 08	6 08	6 09	6 09	6 09	6 09	6 10	6 11	6 12	6 13	6 15	6 17	S.	
8	R.	6 03	6 02	6 01	6 00	5 58	5 57	5 56	5 54	5 53	5 52	5 50	5 49	5 48	5 47	5 45	5 45	5 44	5 43	5 42	5 41	5 40	5 40	5 41	5 42	5 44	R.	8
	S.	6 11	6 11	6 10	6 10	6 10	6 10	6 10	6 09	6 09	6 09	6 09	6 09	6 09	6 09	6 09	6 10	6 10	6 10	6 11	6 11	6 12	6 13	6 15	6 17	6 19	S.	
9	R.	6 03	6 02	6 01	6 00	5 58	5 57	5 55	5 54	5 52	5 51	5 49	5 48	5 47	5 46	5 44	5 44	5 42	5 41	5 40	5 40	5 39	5 39	5 39	5 40	5 42	R.	9
	S.	6 11	6 11	6 11	6 11	6 11	6 11	6 10	6 10	6 10	6 10	6 10	6 10	6 10	6 10	6 10	6 11	6 11	6 11	6 12	6 13	6 14	6 15	6 17	6 19	6 21	S.	
10	R.	6 03	6 02	6 01	6 00	5 58	5 57	5 55	5 53	5 52	5 51	5 49	5 48	5 47	5 45	5 43	5 43	5 41	5 40	5 39	5 38	5 37	5 37	5 37	5 38	5 40	R.	10
	S.	6 11	6 11	6 11	6 11	6 11	6 11	6 11	6 11	6 11	6 11	6 11	6 11	6 11	6 11	6 11	6 12	6 12	6 12	6 13	6 14	6 15	6 16	6 18	6 20	6 22	S.	
11	R.	6 03	6 02	6 01	5 59	5 57	5 56	5 54	5 53	5 51	5 50	5 48	5 47	5 46	5 44	5 42	5 42	5 40	5 39	5 38	5 37	5 36	5 36	5 36	5 36	5 38	R.	11
	S.	6 11	6 11	6 11	6 11	6 11	6 11	6 11	6 11	6 11	6 12	6 12	6 12	6 12	6 12	6 12	6 13	6 13	6 14	6 15	6 16	6 17	6 18	6 20	6 22	6 24	S.	
12	R.	6 03	6 02	6 01	5 59	5 57	5 56	5 54	5 52	5 51	5 49	5 47	5 46	5 45	5 43	5 41	5 41	5 39	5 38	5 37	5 36	5 34	5 34	5 34	5 35	5 36	R.	12
	S.	6 11	6 11	6 11	6 11	6 11	6 12	6 12	6 12	6 12	6 12	6 12	6 12	6 13	6 13	6 13	6 14	6 14	6 15	6 16	6 17	6 18	6 19	6 21	6 24	6 26	S.	
13	R.	6 03	6 02	6 00	5 59	5 57	5 55	5 53	5 52	5 50	5 48	5 46	5 45	5 44	5 42	5 40	5 39	5 38	5 36	5 35	5 34	5 33	5 33	5 33	5 33	5 34	R.	13
	S.	6 11	6 11	6 11	6 12	6 12	6 12	6 12	6 12	6 13	6 13	6 13	6 13	6 14	6 14	6 14	6 15	6 16	6 16	6 17	6 18	6 20	6 21	6 23	6 26	6 28	S.	
14	R.	6 03	6 02	6 00	5 59	5 57	5 55	5 53	5 51	5 49	5 48	5 46	5 44	5 43	5 41	5 39	5 38	5 37	5 35	5 34	5 33	5 32	5 31	5 31	5 31	5 32	R.	14
	S.	6 11	6 11	6 11	6 12	6 12	6 12	6 13	6 13	6 13	6 14	6 14	6 14	6 15	6 15	6 15	6 16	6 17	6 18	6 19	6 20	6 21	6 23	6 25	6 28	6 30	S.	
15	R.	6 03	6 02	6 00	5 58	5 56	5 55	5 53	5 51	5 49	5 47	5 45	5 43	5 42	5 40	5 38	5 37	5 35	5 34	5 32	5 31	5 30	5 29	5 29	5 29	5 30	R.	15
	S.	6 11	6 12	6 12	6 12	6 12	6 13	6 13	6 14	6 14	6 14	6 15	6 15	6 16	6 16	6 16	6 17	6 18	6 19	6 20	6 21	6 23	6 24	6 27	6 30	6 32	S.	
16	R.	6 03	6 02	6 00	5 58	5 56	5 54	5 52	5 50	5 48	5 47	5 45	5 43	5 41	5 39	5 37	5 36	5 34	5 32	5 30	5 29	5 28	5 28	5 28	5 28	5 28	R.	16
	S.	6 11	6 12	6 12	6 12	6 13	6 13	6 14	6 14	6 14	6 15	6 15	6 16	6 17	6 17	6 17	6 18	6 19	6 20	6 21	6 23	6 24	6 26	6 28	6 31	6 34	S.	
17	R.	6 03	6 02	6 00	5 58	5 56	5 54	5 52	5 50	5 48	5 46	5 44	5 42	5 40	5 38	5 36	5 35	5 33	5 31	5 29	5 28	5 26	5 26	5 26	5 26	5 26	R.	17
	S.	6 11	6 12	6 13	6 13	6 13	6 14	6 14	6 15	6 15	6 16	6 16	6 17	6 18	6 18	6 19	6 20	6 21	6 22	6 23	6 25	6 26	6 28	6 30	6 33	6 36	S.	
18	R.	6 03	6 02	6 00	5 58	5 55	5 54	5 51	5 49	5 47	5 45	5 43	5 41	5 39	5 37	5 35	5 34	5 32	5 30	5 28	5 26	5 25	5 24	5 24	5 24	5 24	R.	18
	S.	6 11	6 12	6 12	6 13	6 13	6 14	6 14	6 15	6 16	6 16	6 17	6 18	6 19	6 19	6 20	6 21	6 22	6 23	6 25	6 26	6 28	6 29	6 32	6 35	6 38	S.	
19	R.	6 03	6 01	5 59	5 57	5 55	5 53	5 51	5 49	5 46	5 44	5 42	5 40	5 38	5 36	5 34	5 32	5 30	5 28	5 26	5 25	5 23	5 22	5 22	5 22	5 22	R.	19
	S.	6 11	6 12	6 12	6 13	6 14	6 14	6 15	6 16	6 16	6 17	6 18	6 19	6 20	6 20	6 21	6 22	6 23	6 24	6 26	6 28	6 29	6 31	6 34	6 37	6 40	S.	
20	R.	6 03	6 01	5 59	5 57	5 55	5 53	5 50	5 48	5 46	5 44	5 41	5 39	5 37	5 35	5 33	5 31	5 29	5 27	5 25	5 23	5 22	5 21	5 20	5 20	5 20	R.	20
	S.	6 11	6 12	6 12	6 13	6 14	6 15	6 15	6 16	6 17	6 18	6 19	6 20	6 21	6 21	6 22	6 23	6 25	6 26	6 28	6 29	6 31	6 33	6 36	6 39	6 42	S.	

TABLE 10.

Mean Time of Sun's Visible Rising and Setting.

North Latitude: 21° to 40°—March 21 to June 22.

[R=Local mean time of sun's visible rising. S=Local mean time of sun's visible setting.]

Lat. N.	Approx. date.	MARCH.					APRIL.										MAY.							JUNE.			Approx. date.	Lat. N.
		21	23	26	28	31	3	5	8	11	13	16	19	22	25	28	1	5	8	12	16	21	26	1	10	22		
	Dec. N.	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	13°	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	23° 27′	Dec. N.	
°		h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.		°
21	R.	6 03	6 01	5 59	5 57	5 54	5 52	5 50	5 48	5 45	5 43	5 40	5 38	5 36	5 33	5 31	5 30	5 28	5 25	5 23	5 22	5 20	5 19	5 18	5 17	5 18	R.	21
	S.	6 11	6 12	6 13	6 14	6 14	6 15	6 16	6 17	6 18	6 19	6 20	6 21	6 22	6 22	6 23	6 25	6 26	6 27	6 29	6 31	6 33	6 35	6 38	6 41	6 44	S.	
22	R.	6 03	6 01	5 59	5 57	5 54	5 52	5 49	5 47	5 44	5 42	5 40	5 37	5 35	5 32	5 30	5 28	5 26	5 24	5 22	5 20	5 18	5 17	5 16	5 15	5 16	R.	22
	S.	6 11	6 12	6 13	6 14	6 14	6 15	6 16	6 17	6 18	6 19	6 20	6 21	6 23	6 23	6 24	6 26	6 27	6 29	6 31	6 32	6 34	6 37	6 40	6 43	6 46	S.	
23	R.	6 03	6 01	5 59	5 56	5 54	5 52	5 49	5 47	5 44	5 42	5 39	5 36	5 34	5 31	5 29	5 27	5 25	5 22	5 20	5 18	5 16	5 15	5 14	5 13	5 14	R.	23
	S.	6 11	6 12	6 13	6 14	6 15	6 16	6 17	6 18	6 19	6 20	6 21	6 22	6 24	6 25	6 26	6 27	6 29	6 30	6 32	6 34	6 36	6 39	6 42	6 45	6 48	S.	
24	R.	6 03	6 01	5 59	5 56	5 53	5 51	5 48	5 46	5 43	5 41	5 38	5 35	5 33	5 30	5 28	5 26	5 23	5 21	5 19	5 17	5 15	5 13	5 12	5 11	5 12	R.	24
	S.	6 11	6 12	6 13	6 14	6 15	6 16	6 17	6 18	6 19	6 21	6 22	6 23	6 25	6 26	6 27	6 29	6 30	6 32	6 34	6 36	6 38	6 40	6 44	6 47	6 50	S.	
25	R.	6 03	6 01	5 58	5 56	5 53	5 51	5 48	5 45	5 42	5 40	5 37	5 34	5 32	5 29	5 26	5 24	5 22	5 19	5 17	5 15	5 13	5 11	5 10	5 09	5 10	R.	25
	S.	6 11	6 12	6 13	6 15	6 16	6 17	6 18	6 19	6 20	6 22	6 23	6 24	6 26	6 27	6 28	6 30	6 32	6 33	6 36	6 38	6 40	6 42	6 46	6 50	6 53	S.	
26	R.	6 03	6 01	5 58	5 56	5 53	5 50	5 47	5 45	5 42	5 39	5 36	5 33	5 31	5 28	5 25	5 23	5 20	5 18	5 15	5 13	5 11	5 09	5 08	5 07	5 08	R.	26
	S.	6 11	6 12	6 13	6 15	6 16	6 17	6 18	6 20	6 21	6 22	6 24	6 25	6 27	6 28	6 29	6 31	6 33	6 35	6 37	6 39	6 41	6 44	6 48	6 52	6 55	S.	
27	R.	6 03	6 01	5 58	5 55	5 52	5 50	5 47	5 44	5 41	5 38	5 35	5 32	5 30	5 27	5 24	5 22	5 19	5 16	5 14	5 12	5 09	5 07	5 06	5 05	5 06	R.	27
	S.	6 11	6 13	6 14	6 15	6 16	6 18	6 19	6 20	6 22	6 23	6 25	6 26	6 28	6 29	6 31	6 33	6 35	6 36	6 39	6 41	6 43	6 46	6 50	6 54	6 58	S.	
28	R.	6 03	6 01	5 58	5 55	5 52	5 49	5 46	5 43	5 40	5 37	5 34	5 31	5 29	5 26	5 22	5 20	5 17	5 15	5 12	5 10	5 07	5 06	5 04	5 03	5 04	R.	28
	S.	6 11	6 13	6 14	6 15	6 17	6 18	6 19	6 21	6 23	6 24	6 26	6 27	6 29	6 30	6 32	6 34	6 36	6 38	6 40	6 43	6 45	6 48	6 52	6 56	7 00	S.	
29	R.	6 03	6 01	5 57	5 55	5 52	5 49	5 45	5 42	5 39	5 36	5 33	5 30	5 27	5 24	5 21	5 19	5 16	5 13	5 10	5 08	5 05	5 03	5 01	5 00	5 01	R.	29
	S.	6 11	6 13	6 14	6 16	6 17	6 19	6 20	6 22	6 24	6 25	6 27	6 28	6 30	6 32	6 34	6 36	6 38	6 40	6 42	6 45	6 47	6 50	6 54	6 58	7 02	S.	
30	R.	6 03	6 00	5 57	5 54	5 51	5 48	5 45	5 42	5 38	5 35	5 32	5 29	5 26	5 23	5 20	5 17	5 14	5 11	5 09	5 06	5 03	5 01	4 59	4 58	4 59	R.	30
	S.	6 12	6 13	6 14	6 16	6 17	6 19	6 21	6 23	6 24	6 26	6 28	6 29	6 31	6 33	6 35	6 37	6 39	6 41	6 44	6 46	6 49	6 52	6 56	7 01	7 05	S.	
31	R.	6 03	6 00	5 57	5 54	5 51	5 48	5 44	5 41	5 37	5 34	5 31	5 28	5 25	5 22	5 18	5 16	5 13	5 10	5 07	5 04	5 01	4 59	4 57	4 55	4 56	R.	31
	S.	6 12	6 13	6 15	6 17	6 18	6 20	6 21	6 23	6 25	6 27	6 29	6 31	6 33	6 35	6 37	6 39	6 41	6 43	6 46	6 48	6 51	6 55	6 59	7 03	7 07	S.	
32	R.	6 03	6 00	5 56	5 53	5 50	5 47	5 44	5 41	5 37	5 34	5 30	5 27	5 24	5 21	5 17	5 14	5 11	5 08	5 05	5 02	4 59	4 56	4 54	4 53	4 54	R.	32
	S.	6 12	6 14	6 15	6 17	6 18	6 20	6 22	6 24	6 26	6 28	6 30	6 32	6 34	6 36	6 38	6 40	6 42	6 45	6 48	6 50	6 53	6 57	7 01	7 06	7 10	S.	
33	R.	6 03	6 00	5 56	5 53	5 50	5 47	5 43	5 40	5 36	5 33	5 29	5 26	5 22	5 19	5 15	5 12	5 09	5 06	5 03	5 00	4 57	4 54	4 52	4 50	4 51	R.	33
	S.	6 12	6 14	6 15	6 17	6 19	6 21	6 23	6 25	6 27	6 29	6 31	6 33	6 35	6 37	6 39	6 42	6 44	6 47	6 50	6 53	6 56	6 59	7 04	7 08	7 12	S.	
34	R.	6 03	6 00	5 56	5 53	5 49	5 46	5 42	5 39	5 35	5 32	5 28	5 25	5 21	5 18	5 14	5 11	5 08	5 04	5 01	4 58	4 55	4 52	4 50	4 48	4 49	R.	34
	S.	6 12	6 14	6 16	6 18	6 19	6 21	6 23	6 25	6 27	6 30	6 32	6 34	6 36	6 39	6 41	6 43	6 46	6 49	6 52	6 55	6 58	7 02	7 06	7 11	7 15	S.	
35	R.	6 03	6 00	5 56	5 52	5 49	5 45	5 41	5 38	5 34	5 31	5 27	5 23	5 20	5 16	5 12	5 09	5 06	5 02	4 59	4 56	4 52	4 49	4 47	4 45	4 46	R.	35
	S.	6 12	6 14	6 16	6 18	6 20	6 22	6 24	6 26	6 28	6 31	6 33	6 35	6 38	6 40	6 42	6 45	6 48	6 51	6 54	6 57	7 00	7 04	7 09	7 13	7 18	S.	
36	R.	6 03	6 00	5 56	5 52	5 48	5 45	5 41	5 37	5 33	5 30	5 26	5 22	5 18	5 15	5 11	5 08	5 04	5 00	4 57	4 53	4 50	4 47	4 44	4 42	4 43	R.	36
	S.	6 12	6 14	6 16	6 18	6 20	6 23	6 25	6 27	6 29	6 32	6 34	6 36	6 39	6 42	6 44	6 47	6 50	6 53	6 56	6 59	7 03	7 07	7 11	7 16	7 21	S.	
37	R.	6 03	5 59	5 55	5 52	5 48	5 44	5 40	5 36	5 32	5 28	5 24	5 21	5 17	5 13	5 09	5 06	5 02	4 58	4 54	4 51	4 47	4 44	4 41	4 39	4 40	R.	37
	S.	6 12	6 14	6 16	6 19	6 21	6 24	6 26	6 28	6 30	6 33	6 35	6 38	6 41	6 43	6 46	6 49	6 52	6 55	6 58	7 02	7 05	7 09	7 14	7 19	7 24	S.	
38	R.	6 02	5 59	5 55	5 51	5 47	5 43	5 39	5 35	5 31	5 27	5 23	5 19	5 15	5 12	5 08	5 04	5 00	4 56	4 52	4 49	4 45	4 41	4 38	4 36	4 37	R.	38
	S.	6 12	6 14	6 16	6 19	6 21	6 24	6 26	6 28	6 31	6 34	6 36	6 39	6 42	6 45	6 48	6 51	6 54	6 57	7 00	7 04	7 08	7 12	7 17	7 22	7 27	S.	
39	R.	6 02	5 59	5 55	5 51	5 47	5 43	5 38	5 34	5 30	5 26	5 22	5 18	5 14	5 10	5 06	5 02	4 58	4 54	4 50	4 46	4 42	4 39	4 36	4 33	4 34	R.	39
	S.	6 12	6 15	6 17	6 20	6 22	6 25	6 27	6 29	6 32	6 35	6 38	6 41	6 44	6 47	6 50	6 53	6 56	6 59	7 03	7 06	7 10	7 15	7 20	7 25	7 30	S.	
40	R.	6 02	5 58	5 54	5 50	5 46	5 42	5 38	5 33	5 29	5 25	5 21	5 17	5 12	5 08	5 04	5 00	4 56	4 52	4 48	4 44	4 40	4 36	4 33	4 30	4 31	R.	40
	S.	6 12	6 15	6 17	6 20	6 22	6 25	6 28	6 30	6 33	6 36	6 39	6 42	6 45	6 48	6 51	6 54	6 58	7 01	7 05	7 09	7 13	7 18	7 23	7 28	7 33	S.	

TABLE 10.

Mean Time of Sun's Visible Rising and Setting.

North Latitude: 41° to 60°—March 21 to June 22.

[R=Local mean time of sun's visible rising. S=Local mean time of sun's visible setting.]

Lat. N.	Approx. date.	MARCH.					APRIL.										MAY.							JUNE.			Approx. date.	Lat. N.
		21	23	26	28	31	3	5	8	11	13	16	19	22	25	28	1	5	8	12	16	21	26	1	10	22		
	Dec. N.	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	13°	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	23° 27′	Dec. N.	
°		h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.		°
41	R.	6 02	5 58	5 54	5 50	5 46	5 41	5 37	5 32	5 28	5 24	5 19	5 15	5 11	5 07	5 02	4 58	4 54	4 49	4 45	4 41	4 37	4 33	4 30	4 27	4 27	R.	41
	S.	6 12	6 15	6 18	6 21	6 23	6 26	6 29	6 31	6 34	6 37	6 40	6 43	6 47	6 50	6 53	6 56	7 00	7 03	7 07	7 11	7 16	7 21	7 26	7 31	7 36	S.	
42	R.	6 02	5 58	5 54	5 50	5 45	5 41	5 36	5 32	5 27	5 23	5 18	5 14	5 09	5 05	5 00	4 56	4 52	4 47	4 43	4 39	4 34	4 30	4 27	4 24	4 24	R.	42
	S.	6 12	6 15	6 18	6 21	6 24	6 27	6 29	6 32	6 35	6 38	6 41	6 45	6 48	6 52	6 55	6 58	7 02	7 05	7 09	7 14	7 18	7 23	7 29	7 35	7 40	S.	
43	R.	6 02	5 58	5 53	5 49	5 44	5 40	5 35	5 31	5 26	5 22	5 17	5 12	5 08	5 03	4 58	4 54	4 49	4 45	4 40	4 36	4 31	4 27	4 23	4 20	4 20	R.	43
	S.	6 12	6 15	6 18	6 21	6 24	6 27	6 30	6 33	6 36	6 40	6 43	6 46	6 50	6 53	6 57	7 00	7 04	7 08	7 12	7 17	7 21	7 26	7 32	7 38	7 43	S.	
44	R.	6 02	5 58	5 53	5 49	5 44	5 39	5 34	5 30	5 25	5 21	5 15	5 11	5 06	5 01	4 56	4 52	4 47	4 42	4 37	4 33	4 28	4 24	4 20	4 16	4 16	R.	44
	S.	6 13	6 16	6 19	6 22	6 25	6 28	6 31	6 34	6 37	6 41	6 44	6 48	6 51	6 55	6 59	7 03	7 07	7 11	7 15	7 20	7 25	7 30	7 36	7 42	7 47	S.	
45	R.	6 02	5 57	5 52	5 48	5 43	5 38	5 33	5 28	5 24	5 19	5 14	5 09	5 04	4 59	4 54	4 49	4 44	4 39	4 34	4 30	4 25	4 20	4 16	4 12	4 12	R.	45
	S.	6 13	6 16	6 19	6 22	6 26	6 29	6 32	6 35	6 39	6 42	6 46	6 49	6 53	6 57	7 01	7 05	7 09	7 13	7 18	7 23	7 28	7 34	7 40	7 46	7 51	S.	
46	R.	6 02	5 57	5 52	5 48	5 42	5 37	5 32	5 27	5 22	5 17	5 12	5 08	5 03	4 57	4 52	4 47	4 42	4 36	4 31	4 26	4 21	4 16	4 12	4 08	4 08	R.	46
	S.	6 13	6 16	6 19	6 23	6 26	6 30	6 33	6 36	6 40	6 44	6 47	6 51	6 55	6 59	7 03	7 07	7 12	7 16	7 21	7 26	7 31	7 37	7 43	7 50	7 55	S.	
47	R.	6 02	5 57	5 52	5 47	5 42	5 37	5 31	5 26	5 21	5 16	5 10	5 06	5 01	4 55	4 50	4 45	4 39	4 34	4 28	4 23	4 18	4 13	4 08	4 04	4 04	R.	47
	S.	6 13	6 16	6 20	6 23	6 27	6 31	6 34	6 37	6 41	6 45	6 49	6 53	6 57	7 01	7 05	7 10	7 14	7 19	7 24	7 29	7 35	7 41	7 47	7 54	8 00	S.	
48	R.	6 02	5 57	5 51	5 47	5 41	5 36	5 30	5 25	5 20	5 15	5 09	5 04	4 59	4 53	4 47	4 42	4 36	4 31	4 25	4 20	4 14	4 09	4 04	4 00	3 59	R.	48
	S.	6 13	6 17	6 20	6 24	6 27	6 31	6 35	6 39	6 43	6 47	6 51	6 55	6 59	7 03	7 08	7 13	7 17	7 22	7 27	7 33	7 38	7 44	7 51	7 59	8 04	S.	
49	R.	6 01	5 56	5 51	5 46	5 40	5 35	5 29	5 24	5 18	5 13	5 07	5 02	4 56	4 51	4 45	4 39	4 33	4 27	4 22	4 16	4 11	4 05	4 00	3 55	3 55	R.	49
	S.	6 13	6 17	6 21	6 25	6 28	6 32	6 36	6 40	6 44	6 49	6 53	6 57	7 01	7 06	7 10	7 15	7 20	7 25	7 31	7 36	7 42	7 49	7 56	8 03	8 09	S.	
50	R.	6 01	5 56	5 51	5 45	5 40	5 34	5 28	5 22	5 17	5 11	5 06	5 00	4 54	4 48	4 42	4 36	4 30	4 24	4 18	4 13	4 07	4 01	3 55	3 50	3 50	R.	50
	S.	6 13	6 17	6 21	6 25	6 29	6 33	6 37	6 41	6 46	6 50	6 54	6 59	7 03	7 08	7 13	7 18	7 23	7 28	7 34	7 40	7 46	7 53	8 00	8 06	8 14	S.	
51	R.	6 01	5 56	5 50	5 45	5 39	5 33	5 27	5 21	5 15	5 09	5 03	4 58	4 52	4 46	4 39	4 33	4 27	4 21	4 15	4 09	4 02	3 56	3 51	3 45	3 44	R.	51
	S.	6 13	6 17	6 21	6 26	6 30	6 34	6 39	6 43	6 47	6 52	6 56	7 01	7 06	7 11	7 15	7 21	7 26	7 32	7 38	7 44	7 50	7 57	8 05	8 13	8 19	S.	
52	R.	6 01	5 56	5 50	5 44	5 38	5 32	5 26	5 19	5 14	5 08	5 01	4 55	4 49	4 43	4 36	4 30	4 24	4 17	4 11	4 04	3 58	3 51	3 45	3 40	3 39	R.	52
	S.	6 13	6 18	6 22	6 26	6 31	6 35	6 40	6 44	6 49	6 54	6 58	7 03	7 08	7 13	7 18	7 24	7 30	7 36	7 42	7 48	7 55	8 02	8 10	8 19	8 25	S.	
53	R.	6 01	5 55	5 49	5 43	5 37	5 31	5 24	5 18	5 12	5 06	4 59	4 53	4 47	4 40	4 33	4 27	4 20	4 13	4 07	4 00	3 53	3 46	3 40	3 34	3 33	R.	53
	S.	6 13	6 18	6 23	6 27	6 32	6 37	6 41	6 46	6 51	6 56	7 00	7 05	7 11	7 16	7 21	7 27	7 33	7 39	7 46	7 53	8 00	8 07	8 16	8 25	8 31	S.	
54	R.	6 01	5 55	5 49	5 43	5 36	5 30	5 23	5 16	5 10	5 04	4 57	4 51	4 44	4 37	4 30	4 24	4 17	4 09	4 02	3 55	3 48	3 41	3 34	3 28	3 26	R.	54
	S.	6 14	6 18	6 23	6 28	6 33	6 38	6 42	6 47	6 52	6 58	7 03	7 08	7 13	7 19	7 25	7 31	7 37	7 43	7 50	7 57	8 05	8 13	8 22	8 31	8 37	S.	
55	R.	6 01	5 55	5 48	5 42	5 35	5 29	5 22	5 15	5 08	5 02	4 55	4 48	4 41	4 34	4 27	4 20	4 13	4 05	3 58	3 50	3 43	3 35	3 28	3 21	3 19	R.	55
	S.	6 14	6 19	6 24	6 29	6 34	6 39	6 44	6 49	6 54	7 00	7 05	7 10	7 16	7 22	7 28	7 34	7 41	7 47	7 55	8 02	8 10	8 18	8 28	8 38	8 44	S.	
56	R.	6 01	5 54	5 48	5 41	5 34	5 27	5 20	5 13	5 06	4 59	4 52	4 45	4 38	4 31	4 23	4 16	4 08	4 00	3 53	3 45	3 37	3 29	3 21	3 14	3 12	R.	56
	S.	6 14	6 19	6 24	6 29	6 35	6 40	6 45	6 50	6 56	7 02	7 07	7 13	7 19	7 26	7 32	7 38	7 45	7 52	8 00	8 07	8 15	8 24	8 34	8 45	8 52	S.	
57	R.	6 00	5 54	5 47	5 40	5 33	5 26	5 19	5 11	5 04	4 57	4 49	4 42	4 35	4 27	4 19	4 12	4 04	3 56	3 48	3 39	3 31	3 22	3 14	3 06	3 04	R.	57
	S.	6 14	6 20	6 25	6 30	6 36	6 41	6 47	6 52	6 58	7 04	7 10	7 16	7 23	7 29	7 35	7 42	7 50	7 57	8 05	8 13	8 22	8 31	8 41	8 52	9 00	S.	
58	R.	6 00	5 53	5 46	5 39	5 32	5 25	5 17	5 09	5 02	4 55	4 47	4 39	4 31	4 23	4 15	4 07	3 59	3 50	3 42	3 33	3 24	3 15	3 06	2 57	2 55	R.	58
	S.	6 14	6 20	6 25	6 31	6 37	6 43	6 48	6 54	7 00	7 07	7 13	7 19	7 26	7 33	7 39	7 47	7 55	8 02	8 10	8 19	8 28	8 39	8 50	9 01	9 09	S.	
59	R.	6 00	5 53	5 45	5 38	5 30	5 23	5 15	5 07	5 00	4 52	4 44	4 36	4 28	4 20	4 11	4 02	3 54	3 45	3 36	3 27	3 17	3 07	2 58	2 48	2 45	R.	59
	S.	6 15	6 21	6 26	6 32	6 38	6 44	6 50	6 56	7 03	7 09	7 16	7 23	7 30	7 37	7 44	7 52	8 00	8 08	8 16	8 26	8 36	8 47	8 58	9 10	9 18	S.	
60	R.	6 00	5 52	5 45	5 37	5 29	5 22	5 13	5 05	4 58	4 50	4 41	4 32	4 24	4 16	4 07	3 58	3 48	3 39	3 30	3 20	3 10	3 00	2 50	2 39	2 35	R.	60
	S.	6 15	6 21	6 27	6 33	6 39	6 46	6 52	6 58	7 05	7 12	7 18	7 26	7 33	7 41	7 49	7 57	8 05	8 13	8 23	8 33	8 43	8 54	9 06	9 19	9 28	S.	

TABLE 10.

Mean Time of Sun's Visible Rising and Setting.

North Latitude: 0° to 20°—June 22 to September 23.

[R=Local mean time of sun's visible rising. S=Local mean time of sun's visible setting.]

Lat. N.	Approx. date.	JUNE.	JULY.					AUGUST.										SEPTEMBER.									Approx. date.	Lat. N.
		22	3	13	19	24	28	2	5	9	13	16	19	22	25	28	30	2	5	8	10	13	16	18	21	23		
	Dec. N.	23° 27′	23°	22°	21°	20°	19°	18°	17°	16°	15°	14°	13°	12°	11°	10°	9°	8°	7°	6°	5°	4°	3°	2°	1°	0°	Dec. N.	
°		h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.		°
0	R.	5 57	6 00	6 01	6 02	6 02	6 02	6 02	6 02	6 01	6 01	6 00	6 00	5 59	5 58	5 57	5 57	5 56	5 55	5 54	5 53	5 52	5 51	5 50	5 49	5 49	R.	0
	S.	6 05	6 08	6 09	6 10	6 10	6 10	6 10	6 10	6 09	6 09	6 08	6 08	6 07	6 06	6 05	6 05	6 04	6 03	6 02	6 01	6 00	5 59	5 58	5 57	5 56	S.	
1	R.	5 56	5 58	6 00	6 00	6 01	6 01	6 01	6 01	6 00	6 00	5 59	5 59	5 58	5 58	5 57	5 57	5 56	5 55	5 54	5 53	5 52	5 51	5 50	5 49	5 49	R.	1
	S.	6 07	6 09	6 11	6 11	6 12	6 11	6 11	6 11	6 10	6 10	6 09	6 08	6 07	6 07	6 06	6 05	6 04	6 03	6 02	6 01	6 00	5 59	5 58	5 57	5 56	S.	
2	R.	5 54	5 57	5 58	5 59	5 59	6 00	6 00	6 00	5 59	5 59	5 58	5 58	5 58	5 57	5 56	5 56	5 55	5 54	5 53	5 53	5 52	5 51	5 50	5 49	5 49	R.	2
	S.	6 08	6 11	6 12	6 13	6 13	6 13	6 12	6 12	6 11	6 11	6 10	6 09	6 08	6 07	6 06	6 05	6 04	6 03	6 02	6 01	6 00	5 59	5 58	5 57	5 56	S.	
3	R.	5 52	5 55	5 57	5 57	5 58	5 58	5 59	5 59	5 58	5 58	5 57	5 57	5 57	5 56	5 55	5 55	5 55	5 54	5 53	5 53	5 52	5 51	5 50	5 49	5 49	R.	3
	S.	6 10	6 13	6 14	6 14	6 15	6 14	6 14	6 13	6 12	6 12	6 11	6 10	6 09	6 08	6 07	6 06	6 05	6 04	6 03	6 02	6 01	5 59	5 58	5 57	5 56	S.	
4	R.	5 51	5 53	5 55	5 56	5 56	5 57	5 57	5 57	5 57	5 57	5 56	5 56	5 56	5 56	5 55	5 55	5 54	5 53	5 53	5 53	5 52	5 51	5 50	5 49	5 49	R.	4
	S.	6 12	6 14	6 16	6 16	6 16	6 16	6 15	6 14	6 13	6 13	6 12	6 11	6 10	6 09	6 08	6 07	6 06	6 04	6 03	6 02	6 01	5 59	5 58	5 57	5 56	S.	
5	R.	5 49	5 52	5 53	5 54	5 55	5 55	5 56	5 56	5 56	5 56	5 55	5 55	5 55	5 55	5 54	5 54	5 53	5 53	5 52	5 52	5 51	5 51	5 50	5 49	5 49	R.	5
	S.	6 13	6 16	6 17	6 17	6 18	6 17	6 17	6 16	6 15	6 14	6 13	6 12	6 11	6 10	6 09	6 08	6 06	6 05	6 03	6 02	6 01	6 00	5 59	5 57	5 56	S.	
6	R.	5 47	5 50	5 52	5 53	5 53	5 54	5 55	5 55	5 55	5 55	5 54	5 54	5 54	5 54	5 53	5 53	5 53	5 52	5 52	5 52	5 51	5 51	5 50	5 49	5 48	R.	6
	S.	6 15	6 17	6 19	6 19	6 19	6 18	6 18	6 17	6 16	6 15	6 14	6 13	6 11	6 10	6 09	6 08	6 07	6 05	6 04	6 03	6 01	6 00	5 59	5 57	5 56	S.	
7	R.	5 46	5 48	5 50	5 51	5 52	5 53	5 53	5 53	5 53	5 53	5 53	5 54	5 53	5 53	5 53	5 53	5 52	5 52	5 51	5 51	5 51	5 50	5 50	5 49	5 48	R.	7
	S.	6 17	6 19	6 21	6 21	6 21	6 20	6 19	6 18	6 17	6 16	6 15	6 14	6 12	6 11	6 10	6 09	6 07	6 06	6 04	6 03	6 02	6 00	5 59	5 57	5 56	S.	
8	R.	5 44	5 46	5 48	5 49	5 50	5 51	5 52	5 52	5 52	5 52	5 52	5 53	5 52	5 52	5 52	5 52	5 52	5 51	5 51	5 51	5 50	5 50	5 50	5 49	5 48	R.	8
	S.	6 19	6 21	6 22	6 22	6 22	6 21	6 21	6 19	6 18	6 17	6 16	6 15	6 13	6 12	6 11	6 09	6 08	6 06	6 05	6 04	6 02	6 00	5 59	5 57	5 56	S.	
9	R.	5 42	5 44	5 46	5 48	5 49	5 50	5 50	5 51	5 51	5 51	5 51	5 52	5 51	5 51	5 51	5 51	5 51	5 51	5 50	5 50	5 50	5 50	5 49	5 49	5 48	R.	9
	S.	6 21	6 23	6 24	6 24	6 24	6 23	6 22	6 21	6 20	6 18	6 17	6 16	6 14	6 13	6 12	6 10	6 09	6 07	6 05	6 04	6 03	6 01	5 59	5 58	5 56	S.	
10	R.	5 40	5 43	5 45	5 46	5 47	5 48	5 49	5 50	5 50	5 50	5 50	5 51	5 51	5 51	5 50	5 50	5 50	5 50	5 50	5 50	5 50	5 50	5 49	5 49	5 48	R.	10
	S.	6 22	6 25	6 26	6 25	6 25	6 24	6 23	6 22	6 21	6 19	6 18	6 17	6 15	6 14	6 12	6 11	6 09	6 07	6 06	6 05	6 03	6 01	5 59	5 58	5 56	S.	
11	R.	5 38	5 41	5 43	5 45	5 46	5 47	5 48	5 48	5 49	5 49	5 49	5 50	5 50	5 50	5 50	5 50	5 50	5 50	5 49	5 49	5 49	5 49	5 49	5 49	5 48	R.	11
	S.	6 24	6 27	6 27	6 27	6 27	6 26	6 25	6 23	6 22	6 20	6 19	6 18	6 16	6 15	6 13	6 12	6 10	6 08	6 06	6 05	6 03	6 01	5 59	5 58	5 56	S.	
12	R.	5 36	5 39	5 42	5 43	5 44	5 46	5 47	5 47	5 48	5 48	5 48	5 49	5 49	5 49	5 49	5 49	5 49	5 49	5 49	5 49	5 49	5 49	5 49	5 49	5 48	R.	12
	S.	6 26	6 28	6 29	6 28	6 28	6 27	6 26	6 24	6 23	6 21	6 20	6 19	6 17	6 15	6 14	6 12	6 10	6 08	6 07	6 05	6 03	6 01	5 59	5 58	5 56	S.	
13	R.	5 34	5 37	5 40	5 42	5 43	5 44	5 45	5 46	5 46	5 47	5 47	5 48	5 48	5 48	5 48	5 48	5 48	5 48	5 48	5 49	5 49	5 49	5 49	5 49	5 48	R.	13
	S.	6 28	6 30	6 31	6 30	6 30	6 28	6 27	6 26	6 24	6 23	6 21	6 20	6 18	6 16	6 15	6 13	6 11	6 09	6 07	6 06	6 04	6 02	6 00	5 58	5 56	S.	
14	R.	5 32	5 35	5 38	5 40	5 41	5 43	5 44	5 45	5 45	5 46	5 46	5 47	5 47	5 47	5 47	5 48	5 48	5 48	5 48	5 49	5 49	5 49	5 49	5 49	5 48	R.	14
	S.	6 30	6 32	6 32	6 32	6 31	6 30	6 29	6 27	6 25	6 24	6 22	6 21	6 19	6 17	6 15	6 14	6 12	6 10	6 08	6 06	6 04	6 02	6 00	5 58	5 56	S.	
15	R.	5 30	5 33	5 36	5 38	5 40	5 41	5 42	5 43	5 44	5 45	5 45	5 46	5 46	5 46	5 46	5 47	5 47	5 47	5 47	5 48	5 48	5 48	5 48	5 48	5 48	R.	15
	S.	6 32	6 34	6 34	6 33	6 33	6 31	6 30	6 28	6 27	6 25	6 23	6 22	6 20	6 18	6 16	6 14	6 12	6 10	6 08	6 06	6 04	6 02	6 00	5 58	5 56	S.	
16	R.	5 28	5 32	5 35	5 37	5 38	5 40	5 41	5 42	5 43	5 44	5 44	5 45	5 45	5 46	5 46	5 47	5 47	5 47	5 47	5 48	5 48	5 48	5 48	5 48	5 48	R.	16
	S.	6 34	6 36	6 36	6 35	6 34	6 33	6 32	6 30	6 28	6 26	6 24	6 23	6 21	6 19	6 17	6 15	6 13	6 11	6 09	6 07	6 05	6 02	6 00	5 58	5 56	S.	
17	R.	5 26	5 30	5 33	5 35	5 36	5 38	5 39	5 40	5 41	5 42	5 43	5 44	5 44	5 45	5 45	5 46	5 46	5 46	5 46	5 47	5 47	5 48	5 48	5 48	5 48	R.	17
	S.	6 36	6 38	6 38	6 37	6 36	6 35	6 33	6 31	6 29	6 27	6 26	6 24	6 22	6 20	6 18	6 16	6 14	6 11	6 09	6 07	6 05	6 03	6 00	5 58	5 56	S.	
18	R.	5 24	5 28	5 31	5 33	5 35	5 36	5 38	5 39	5 40	5 41	5 42	5 43	5 43	5 44	5 44	5 45	5 45	5 46	5 46	5 47	5 47	5 48	5 48	5 48	5 48	R.	18
	S.	6 38	6 39	6 39	6 38	6 38	6 36	6 35	6 32	6 30	6 28	6 27	6 25	6 23	6 21	6 18	6 16	6 14	6 12	6 09	6 07	6 05	6 03	6 00	5 58	5 56	S.	
19	R.	5 22	5 26	5 29	5 31	5 33	5 35	5 36	5 38	5 39	5 40	5 41	5 42	5 42	5 43	5 43	5 44	5 45	5 45	5 46	5 47	5 47	5 47	5 48	5 48	5 48	R.	19
	S.	6 40	6 41	6 41	6 40	6 39	6 38	6 36	6 34	6 32	6 30	6 28	6 26	6 24	6 22	6 19	6 17	6 15	6 12	6 10	6 08	6 06	6 03	6 01	5 58	5 56	S.	
20	R.	5 20	5 24	5 27	5 30	5 32	5 33	5 35	5 36	5 37	5 39	5 40	5 41	5 41	5 42	5 43	5 44	5 44	5 45	5 45	5 46	5 47	5 47	5 48	5 48	5 48	R.	20
	S.	6 42	6 43	6 43	6 42	6 41	6 39	6 37	6 35	6 33	6 31	6 29	6 27	6 25	6 22	6 20	6 18	6 15	6 13	6 10	6 08	6 06	6 03	6 01	5 58	5 56	S.	

TABLE 10.

Mean Time of Sun's Visible Rising and Setting.

North Latitude: 21° to 40°—June 22 to September 23.

[R=Local mean time of sun's visible rising. S=Local mean time of sun's visible setting.]

Lat. N.	Approx. date.	JUNE.	JULY.					AUGUST.										SEPTEMBER.									Approx. date.	Lat. N.
		22	3	12	19	24	28	2	5	9	12	16	19	22	25	28	30	1	5	8	10	13	16	18	21	23		
	Dec. N.	23° 27′	23°	22°	21°	20°	19°	18°	17°	16°	15°	14°	13°	12°	11°	10°	9°	8°	7°	6°	5°	4°	3°	2°	1°	0°	Dec. N.	
°		h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.		°
21	R.	5 18	5 22	5 25	5 28	5 30	5 32	5 33	5 35	5 36	5 37	5 38	5 39	5 40	5 41	5 42	5 43	5 43	5 44	5 45	5 46	5 46	5 47	5 47	5 48	5 48	R.	21
	S.	6 44	6 46	6 45	6 44	6 43	6 41	6 39	6 37	6 35	6 32	6 30	6 28	6 26	6 23	6 21	6 19	6 16	6 13	6 11	6 09	6 06	6 04	6 01	5 59	5 56	S.	
22	R.	5 16	5 20	5 23	5 26	5 28	5 30	5 32	5 33	5 35	5 36	5 37	5 38	5 39	5 40	5 41	5 42	5 43	5 44	5 44	5 45	5 46	5 47	5 47	5 48	5 48	R.	22
	S.	6 46	6 48	6 47	6 46	6 44	6 42	6 40	6 38	6 36	6 33	6 31	6 29	6 27	6 24	6 21	6 19	6 17	6 14	6 11	6 09	6 06	6 04	6 01	5 59	5 56	S.	
23	R.	5 14	5 18	5 21	5 24	5 26	5 28	5 30	5 32	5 34	5 35	5 36	5 37	5 38	5 39	5 40	5 42	5 42	5 43	5 44	5 45	5 46	5 46	5 47	5 48	5 48	R.	23
	S.	6 48	6 50	6 49	6 48	6 46	6 44	6 42	6 40	6 37	6 35	6 33	6 30	6 28	6 25	6 22	6 20	6 17	6 14	6 12	6 10	6 07	6 04	6 01	5 59	5 56	S.	
24	R.	5 12	5 16	5 19	5 22	5 25	5 27	5 29	5 30	5 32	5 33	5 35	5 36	5 37	5 38	5 39	5 41	5 42	5 43	5 43	5 44	5 45	5 46	5 47	5 48	5 48	R.	24
	S.	6 50	6 52	6 51	6 49	6 48	6 46	6 44	6 41	6 39	6 36	6 34	6 31	6 29	6 26	6 23	6 21	6 18	6 15	6 12	6 10	6 07	6 04	6 01	5 59	5 56	S.	
25	R.	5 10	5 13	5 17	5 20	5 23	5 25	5 27	5 29	5 30	5 32	5 33	5 35	5 36	5 37	5 38	5 40	5 41	5 42	5 43	5 44	5 45	5 46	5 47	5 48	5 48	R.	25
	S.	6 53	6 54	6 53	6 51	6 50	6 48	6 46	6 43	6 40	6 38	6 35	6 33	6 30	6 27	6 24	6 22	6 19	6 16	6 13	6 10	6 08	6 05	6 02	5 59	5 56	S.	
26	R.	5 08	5 11	5 15	5 18	5 21	5 23	5 26	5 27	5 29	5 31	5 32	5 34	5 35	5 36	5 37	5 39	5 40	5 41	5 42	5 44	5 45	5 46	5 47	5 48	5 48	R.	26
	S.	6 55	6 56	6 55	6 53	6 51	6 49	6 47	6 44	6 42	6 39	6 36	6 34	6 31	6 28	6 25	6 22	6 19	6 16	6 13	6 11	6 08	6 06	6 02	5 59	5 56	S.	
27	R.	5 06	5 09	5 13	5 16	5 19	5 22	5 24	5 26	5 27	5 29	5 31	5 33	5 34	5 35	5 36	5 38	5 39	5 41	5 42	5 43	5 44	5 45	5 46	5 47	5 48	R.	27
	S.	6 58	6 58	6 57	6 55	6 53	6 51	6 49	6 46	6 43	6 40	6 38	6 35	6 32	6 29	6 26	6 23	6 20	6 17	6 14	6 11	6 08	6 05	6 02	5 59	5 57	S.	
28	R.	5 04	5 07	5 11	5 14	5 17	5 20	5 22	5 24	5 26	5 28	5 29	5 31	5 33	5 34	5 35	5 37	5 38	5 40	5 41	5 43	5 44	5 45	5 46	5 47	5 48	R.	28
	S.	7 00	7 00	6 59	6 57	6 55	6 53	6 50	6 47	6 45	6 42	6 39	6 36	6 33	6 30	6 27	6 24	6 21	6 18	6 15	6 12	6 09	6 06	6 03	6 00	5 57	S.	
29	R.	5 01	5 05	5 09	5 12	5 15	5 18	5 20	5 22	5 24	5 26	5 28	5 30	5 31	5 33	5 34	5 36	5 37	5 39	5 40	5 42	5 44	5 45	5 46	5 47	5 48	R.	29
	S.	7 02	7 03	7 02	6 59	6 57	6 55	6 52	6 49	6 46	6 43	6 41	6 38	6 34	6 31	6 28	6 25	6 22	6 19	6 15	6 12	6 09	6 06	6 03	6 00	5 57	S.	
30	R.	4 59	5 02	5 07	5 10	5 13	5 16	5 19	5 21	5 23	5 25	5 27	5 29	5 30	5 32	5 33	5 35	5 37	5 38	5 40	5 42	5 43	5 44	5 46	5 47	5 48	R.	30
	S.	7 05	7 05	7 04	7 01	6 59	6 56	6 53	6 51	6 48	6 45	6 42	6 39	6 35	6 32	6 29	6 26	6 23	6 19	6 16	6 13	6 09	6 06	6 03	6 00	5 57	S.	
31	R.	4 56	5 00	5 04	5 08	5 11	5 14	5 17	5 19	5 21	5 23	5 25	5 27	5 29	5 31	5 32	5 34	5 36	5 38	5 39	5 41	5 43	5 44	5 45	5 47	5 48	R.	31
	S.	7 07	7 08	7 06	7 04	7 01	6 58	6 55	6 52	6 49	6 46	6 43	6 40	6 37	6 34	6 30	6 27	6 24	6 20	6 16	6 13	6 10	6 07	6 03	6 00	5 57	S.	
32	R.	4 54	4 58	5 02	5 06	5 09	5 12	5 15	5 17	5 20	5 22	5 24	5 26	5 28	5 30	5 31	5 33	5 35	5 37	5 39	5 41	5 42	5 43	5 45	5 46	5 48	R.	32
	S.	7 10	7 10	7 09	7 06	7 03	7 00	6 57	6 54	6 51	6 48	6 45	6 41	6 38	6 35	6 31	6 28	6 24	6 20	6 17	6 14	6 10	6 07	6 04	6 00	5 57	S.	
33	R.	4 51	4 55	4 59	5 03	5 07	5 10	5 13	5 15	5 18	5 20	5 22	5 24	5 26	5 28	5 30	5 32	5 34	5 36	5 38	5 40	5 42	5 43	5 45	5 46	5 48	R.	33
	S.	7 12	7 13	7 11	7 08	7 06	7 03	7 00	6 56	6 53	6 49	6 46	6 43	6 39	6 36	6 32	6 29	6 25	6 21	6 18	6 15	6 11	6 07	6 04	6 00	5 57	S.	
34	R.	4 49	4 52	4 57	5 01	5 05	5 08	5 11	5 13	5 16	5 19	5 21	5 23	5 25	5 27	5 29	5 31	5 34	5 36	5 37	5 39	5 41	5 43	5 45	5 46	5 48	R.	34
	S.	7 15	7 15	7 14	7 11	7 08	7 05	7 02	6 58	6 54	6 51	6 48	6 44	6 40	6 37	6 33	6 30	6 26	6 22	6 18	6 15	6 11	6 08	6 04	6 00	5 57	S.	
35	R.	4 46	4 50	4 54	4 58	5 02	5 06	5 09	5 11	5 14	5 17	5 19	5 22	5 24	5 26	5 28	5 30	5 33	5 35	5 37	5 39	5 41	5 42	5 44	5 46	5 48	R.	35
	S.	7 18	7 18	7 16	7 13	7 10	7 07	7 04	7 00	6 56	6 53	6 49	6 46	6 42	6 38	6 34	6 31	6 27	6 23	6 19	6 16	6 12	6 08	6 04	6 00	5 57	S.	
36	R.	4 43	4 47	4 52	4 56	5 00	5 03	5 06	5 09	5 12	5 15	5 18	5 20	5 22	5 25	5 27	5 29	5 32	5 34	5 36	5 38	5 40	5 42	5 44	5 46	5 48	R.	36
	S.	7 21	7 21	7 19	7 16	7 13	7 09	7 06	7 02	6 58	6 54	6 51	6 47	6 43	6 39	6 35	6 32	6 28	6 24	6 20	6 16	6 12	6 08	6 04	6 00	5 57	S.	
37	R.	4 40	4 44	4 49	4 53	4 57	5 01	5 04	5 07	5 10	5 13	5 16	5 19	5 21	5 24	5 26	5 28	5 31	5 33	5 35	5 37	5 40	5 42	5 44	5 46	5 48	R.	37
	S.	7 24	7 24	7 21	7 18	7 15	7 12	7 08	7 04	7 00	6 56	6 53	6 49	6 45	6 41	6 37	6 33	6 29	6 25	6 21	6 17	6 13	6 09	6 05	6 01	5 57	S.	
38	R.	4 37	4 41	4 46	4 51	4 55	4 59	5 02	5 05	5 08	5 11	5 14	5 17	5 19	5 22	5 25	5 27	5 30	5 32	5 34	5 37	5 39	5 41	5 44	5 46	5 47	R.	38
	S.	7 27	7 27	7 24	7 21	7 18	7 14	7 10	7 06	7 02	6 58	6 54	6 50	6 46	6 42	6 38	6 34	6 30	6 25	6 21	6 18	6 13	6 09	6 05	6 01	5 57	S.	
39	R.	4 34	4 38	4 43	4 48	4 52	4 56	5 00	5 03	5 06	5 09	5 12	5 15	5 18	5 21	5 23	5 26	5 29	5 31	5 33	5 36	5 39	5 41	5 43	5 45	5 47	R.	39
	S.	7 30	7 30	7 27	7 24	7 20	7 16	7 13	7 08	7 04	7 00	6 56	6 52	6 48	6 44	6 39	6 35	6 31	6 26	6 22	6 18	6 14	6 10	6 05	6 01	5 57	S.	
40	R.	4 31	4 35	4 40	4 45	4 50	4 54	4 58	5 01	5 04	5 08	5 11	5 14	5 17	5 20	5 22	5 25	5 28	5 30	5 33	5 36	5 38	5 40	5 43	5 45	5 47	R.	40
	S.	7 33	7 33	7 30	7 26	7 23	7 19	7 15	7 10	7 06	7 02	6 58	6 54	6 49	6 45	6 40	6 36	6 32	6 27	6 23	6 19	6 14	6 10	6 06	6 01	5 57	S.	

TABLE 10.

Mean Time of Sun's Visible Rising and Setting.

North Latitude: 41° to 60°.—June 22 to September 23.

[R=Local mean time of sun's visible rising. S=Local mean time of sun's visible setting.]

Lat. N.	Approx. date.	JUNE.	JULY.					AUGUST.										SEPTEMBER.									Approx. date.	Lat. N.
		22	3	12	19	24	28	2	5	9	12	16	19	22	25	28	30	2	5	8	10	13	16	18	21	23		
	Dec. N.	23° 27′	23°	22°	21°	20°	19°	18°	17°	16°	15°	14°	13°	12°	11°	10°	9°	8°	7°	6°	5°	4°	3°	2°	1°	0°	Dec. N.	
°		h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.		°
41	R.	4 27	4 32	4 37	4 42	4 47	4 51	4 55	4 59	5 02	5 06	5 09	5 12	5 15	5 18	5 21	5 24	5 27	5 29	5 32	5 35	5 38	5 40	5 42	5 45	5 47	R.	41
	S.	7 36	7 36	7 33	7 29	7 26	7 21	7 17	7 13	7 08	7 04	7 00	6 55	6 51	6 46	6 42	6 37	6 33	6 28	6 24	6 20	6 15	6 10	6 06	6 02	5 57	S.	
42	R.	4 24	4 29	4 34	4 39	4 44	4 49	4 53	4 57	5 00	5 04	5 07	5 10	5 13	5 17	5 20	5 23	5 26	5 29	5 31	5 34	5 37	5 40	5 42	5 45	5 47	R.	42
	S.	7 40	7 39	7 36	7 32	7 28	7 24	7 20	7 15	7 10	7 06	7 02	6 57	6 52	6 48	6 43	6 38	6 34	6 29	6 24	6 20	6 16	6 11	6 06	6 02	5 57	S.	
43	R.	4 20	4 25	4 31	4 36	4 41	4 46	4 50	4 54	4 58	5 02	5 05	5 09	5 12	5 15	5 18	5 22	5 25	5 28	5 30	5 33	5 36	5 39	5 42	5 45	5 47	R.	43
	S.	7 43	7 43	7 40	7 35	7 31	7 27	7 22	7 17	7 13	7 08	7 04	6 59	6 54	6 49	6 44	6 40	6 35	6 30	6 25	6 21	6 16	6 11	6 07	6 02	5 57	S.	
44	R.	4 16	4 21	4 27	4 33	4 38	4 43	4 47	4 51	4 55	4 59	5 03	5 07	5 10	5 14	5 17	5 21	5 24	5 27	5 29	5 32	5 35	5 38	5 41	5 44	5 47	R.	44
	S.	7 47	7 47	7 44	7 39	7 34	7 30	7 25	7 20	7 15	7 10	7 06	7 01	6 56	6 51	6 46	6 41	6 36	6 31	6 26	6 22	6 17	6 12	6 07	6 02	5 58	S.	
45	R.	4 12	4 17	4 23	4 29	4 35	4 40	4 44	4 49	4 53	4 57	5 01	5 05	5 08	5 12	5 16	5 19	5 22	5 25	5 28	5 32	5 35	5 38	5 41	5 44	5 47	R.	45
	S.	7 51	7 51	7 47	7 42	7 38	7 33	7 28	7 23	7 18	7 13	7 08	7 03	6 57	6 52	6 47	6 42	6 37	6 32	6 27	6 23	6 18	6 13	6 08	6 03	5 58	S.	
46	R.	4 08	4 13	4 19	4 25	4 31	4 36	4 41	4 46	4 50	4 55	4 59	5 03	5 07	5 11	5 14	5 18	5 21	5 24	5 27	5 31	5 34	5 38	5 41	5 44	5 47	R.	46
	S.	7 55	7 55	7 51	7 46	7 41	7 36	7 31	7 26	7 20	7 15	7 10	7 05	6 59	6 54	6 49	6 44	6 38	6 33	6 28	6 23	6 18	6 13	6 08	6 03	5 58	S.	
47	R.	4 04	4 09	4 16	4 22	4 28	4 33	4 38	4 43	4 48	4 52	4 56	5 01	5 05	5 09	5 12	5 16	5 20	5 23	5 26	5 30	5 34	5 37	5 40	5 44	5 47	R.	47
	S.	8 00	7 59	7 55	7 50	7 45	7 39	7 34	7 28	7 23	7 17	7 12	7 07	7 01	6 56	6 51	6 45	6 40	6 34	6 29	6 24	6 19	6 13	6 08	6 03	5 58	S.	
48	R.	3 59	4 04	4 11	4 18	4 24	4 30	4 35	4 40	4 45	4 49	4 54	4 59	5 03	5 07	5 10	5 14	5 18	6 22	5 25	5 29	5 33	5 37	5 40	5 43	5 47	R.	48
	S.	8 04	8 03	7 59	7 53	7 48	7 43	7 37	7 31	7 26	7 20	7 15	7 09	7 03	6 58	6 59	6 47	6 41	6 36	6 30	6 25	6 19	6 14	6 09	6 03	5 58	S.	
49	R.	3 55	4 00	4 07	4 14	4 21	4 26	4 32	4 37	4 42	4 47	4 51	4 56	5 00	5 05	5 09	5 13	5 17	5 21	5 24	5 28	5 32	5 36	5 39	5 43	5 47	R.	49
	S.	8 09	8 08	8 03	7 57	7 52	7 46	7 41	7 35	7 29	7 23	7 17	7 11	7 05	7 00	6 54	6 49	6 43	6 37	6 31	6 26	6 20	6 15	6 09	6 04	5 58	S.	
50	R.	3 50	3 55	4 03	4 10	4 17	4 23	4 28	4 34	4 39	4 44	4 49	4 54	4 58	5 03	5 07	5 11	5 15	5 19	5 23	5 28	5 32	5 35	5 39	5 43	5 46	R.	50
	S.	8 14	8 13	8 08	8 02	7 56	7 50	7 44	7 38	7 32	7 26	7 20	7 14	7 07	7 02	6 56	6 50	6 44	6 38	6 32	6 27	6 21	6 15	6 09	6 04	5 58	S.	
51	R.	3 44	3 50	3 58	4 05	4 12	4 19	4 25	4 30	4 36	4 41	4 46	4 51	4 56	5 01	5 05	5 10	5 14	5 18	5 22	5 27	5 31	5 35	5 39	5 43	5 46	R.	51
	S.	8 19	8 18	8 12	8 06	8 00	7 54	7 48	7 41	7 35	7 29	7 22	7 16	7 10	7 04	6 58	6 52	6 46	6 40	6 34	6 28	6 22	6 16	6 10	6 04	5 58	S.	
52	R.	3 39	3 44	3 53	4 00	4 08	4 14	4 21	4 27	4 32	4 38	4 43	4 49	4 53	4 58	5 03	5 08	5 12	5 16	5 21	5 26	5 30	5 34	5 38	5 42	5 46	R.	52
	S.	8 25	8 23	8 18	8 11	8 05	7 58	7 52	7 45	7 38	7 32	7 25	7 19	7 12	7 06	7 00	6 54	6 47	6 41	6 35	6 29	6 23	6 16	6 10	6 04	5 58	S.	
53	R.	3 33	3 38	3 47	3 55	4 03	4 10	4 17	4 23	4 29	4 35	4 40	4 46	4 51	4 56	5 01	5 06	5 10	5 15	5 19	5 24	5 29	5 33	5 38	5 42	5 46	R.	53
	S.	8 31	8 29	8 23	8 16	8 10	8 03	7 56	7 49	7 42	7 35	7 28	7 22	7 15	7 08	7 02	6 56	6 49	6 43	6 36	6 30	6 24	6 17	6 11	6 05	5 58	S.	
54	R.	3 26	3 32	3 41	3 50	3 58	4 05	4 12	4 19	4 25	4 31	4 37	4 43	4 48	4 54	4 59	5 04	5 09	5 13	5 18	5 23	5 28	5 33	5 37	5 42	5 46	R.	54
	S.	8 37	8 35	8 29	8 22	8 15	8 07	8 00	7 53	7 45	7 38	7 31	7 25	7 18	7 11	7 04	6 58	6 51	6 44	6 37	6 31	6 25	6 18	6 11	6 05	5 59	S.	
55	R.	3 19	3 25	3 35	3 44	3 53	4 00	4 08	4 15	4 21	4 28	4 34	4 40	4 45	4 51	4 56	5 02	5 07	5 12	5 17	5 22	5 27	5 32	5 37	5 41	5 46	R.	55
	S.	8 44	8 42	8 35	8 27	8 20	8 12	8 05	7 57	7 49	7 42	7 35	7 28	7 20	7 13	7 06	7 00	6 53	6 46	6 39	6 32	6 26	6 19	6 12	6 05	5 59	S.	
56	R.	3 12	3 18	3 29	3 38	3 47	3 55	4 03	4 10	4 17	4 24	4 30	4 36	4 42	4 48	4 54	5 00	5 05	5 10	5 15	5 21	5 26	5 31	5 36	5 41	5 45	R.	56
	S.	8 52	8 49	8 42	8 33	8 25	8 17	8 10	8 02	7 54	7 46	7 38	7 31	7 23	7 16	7 09	7 02	6 55	6 47	6 40	6 34	6 27	6 19	6 12	6 06	5 59	S.	
57	R.	3 04	3 11	3 22	3 31	3 41	3 49	3 58	4 05	4 12	4 19	4 26	4 33	4 39	4 45	4 51	4 57	5 03	5 08	5 14	5 20	5 25	5 30	5 35	5 40	5 45	R.	57
	S.	9 00	8 57	8 49	8 40	8 32	8 23	8 15	8 06	7 58	7 50	7 42	7 35	7 27	7 19	7 12	7 04	6 57	6 49	6 42	6 35	6 28	6 20	6 13	6 06	5 59	S.	
58	R.	2 55	3 02	3 14	3 24	3 34	3 43	3 52	4 00	4 07	4 15	4 22	4 29	4 35	4 42	4 48	4 55	5 01	5 06	5 12	5 18	5 24	5 29	5 35	5 40	5 45	R.	58
	S.	9 09	9 06	8 57	8 48	8 38	8 29	8 20	8 12	8 03	7 55	7 46	7 38	7 30	7 22	7 14	7 07	6 59	6 51	6 43	6 36	6 29	6 21	6 14	6 07	5 59	S.	
59	R.	2 45	2 53	3 05	3 16	3 27	3 37	3 46	3 54	4 02	4 10	4 18	4 25	4 32	4 39	4 45	4 52	4 58	5 04	5 10	5 16	5 22	5 28	5 34	5 39	5 45	R.	59
	S.	9 18	9 15	9 05	8 55	8 45	8 36	8 26	8 17	8 08	8 00	7 51	7 42	7 34	7 26	7 17	7 09	7 01	6 53	6 45	6 38	6 30	6 22	6 15	6 07	6 00	S.	
60	R.	2 35	2 43	2 57	3 09	3 20	3 30	3 40	3 49	3 57	4 05	4 13	4 21	4 28	4 36	4 43	4 50	4 56	5 02	5 08	5 15	5 21	5 27	5 33	5 39	5 45	R.	60
	S.	9 28	9 25	9 13	9 03	8 53	8 43	8 33	8 23	8 14	8 04	7 55	7 46	7 37	7 29	7 20	7 12	7 03	6 55	6 47	6 39	6 31	6 23	6 15	6 08	6 00	S.	

TABLE 10.

Mean Time of Sun's Visible Rising and Setting.

North Latitude: 0° to 20°—September 23 to December 22.

[R=Local mean time of sun's visible rising. S=Local mean time of sun's visible setting.]

Lat. N.	Approx. date.	SEPTEMBER.			OCTOBER.												NOVEMBER.							DECEMBER.			Approx. date.	Lat. N.
		23	26	28	1	4	6	9	11	14	17	19	22	25	28	31	3	6	10	14	17	22	27	3	11	22		
	Dec. S.	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	13°	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	23° 27′	Dec. S.	
°		h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.		°
0	R.	5 49	5 48	5 47	5 46	5 45	5 44	5 44	5 43	5 42	5 42	5 41	5 41	5 40	5 40	5 40	5 40	5 40	5 40	5 40	5 41	5 42	5 44	5 46	5 49	5 54	R.	0
	S.	5 56	5 55	5 55	5 54	5 53	5 52	5 52	5 51	5 50	5 50	5 49	5 49	5 48	5 48	5 48	5 48	5 48	5 48	5 48	5 49	5 50	5 52	5 54	5 57	6 02	S.	
1	R.	5 49	5 48	5 47	5 46	5 46	5 45	5 44	5 43	5 43	5 43	5 42	5 42	5 41	5 41	5 41	5 41	5 41	5 41	5 42	5 43	5 44	5 45	5 47	5 51	5 56	R.	1
	S.	5 56	5 55	5 54	5 53	5 53	5 52	5 51	5 50	5 49	5 49	5 48	5 48	5 47	5 47	5 47	5 47	5 46	5 46	5 47	5 48	5 49	5 50	5 52	5 56	6 01	S.	
2	R.	5 49	5 48	5 47	5 46	5 46	5 45	5 45	5 44	5 44	5 43	5 43	5 42	5 42	5 41	5 42	5 42	5 42	5 42	5 43	5 44	5 45	5 47	5 49	5 52	5 57	R.	2
	S.	5 56	5 55	5 54	5 53	5 53	5 52	5 51	5 50	5 49	5 48	5 48	5 47	5 47	5 46	5 46	5 46	5 45	5 45	5 46	5 47	5 47	5 49	5 51	5 54	5 59	S.	
3	R.	5 49	5 48	5 47	5 46	5 46	5 45	5 45	5 44	5 44	5 44	5 43	5 43	5 43	5 42	5 43	5 43	5 43	5 43	5 44	5 45	5 47	5 48	5 50	5 54	5 59	R.	3
	S.	5 56	5 55	5 54	5 53	5 52	5 51	5 50	5 49	5 48	5 48	5 47	5 47	5 46	5 45	5 45	5 45	5 44	5 44	5 44	5 45	5 46	5 47	5 49	5 53	5 57	S.	
4	R.	5 49	5 48	5 47	5 47	5 46	5 45	5 45	5 45	5 45	5 44	5 44	5 44	5 44	5 43	5 44	5 44	5 44	5 44	5 45	5 47	5 48	5 50	5 52	5 55	6 01	R.	4
	S.	5 56	5 55	5 54	5 53	5 52	5 51	5 50	5 49	5 48	5 47	5 47	5 46	5 45	5 44	5 44	5 44	5 43	5 43	5 43	5 44	5 44	5 46	5 48	5 51	5 56	S.	
5	R.	5 49	5 48	5 47	5 47	5 47	5 46	5 46	5 45	5 45	5 45	5 45	5 45	5 45	5 44	5 45	5 45	5 46	5 46	5 47	5 48	5 50	5 51	5 54	5 57	6 08	R.	5
	S.	5 56	5 55	5 54	5 53	5 52	5 51	5 50	5 48	5 47	5 47	5 46	5 45	5 44	5 43	5 43	5 42	5 42	5 42	5 42	5 42	5 43	5 44	5 46	5 49	5 54	S.	
6	R.	5 48	5 48	5 47	5 47	5 47	5 46	5 46	5 46	5 46	5 45	5 45	5 45	5 45	5 45	5 46	5 46	5 47	5 47	5 48	5 49	5 51	5 53	5 55	5 59	6 04	R.	6
	S.	5 56	5 55	5 54	5 53	5 52	5 50	5 49	5 48	5 47	5 46	5 45	5 44	5 43	5 42	5 42	5 41	5 41	5 41	5 41	5 41	5 42	5 43	5 44	5 48	5 52	S.	
7	R.	5 48	5 48	5 48	5 47	5 47	5 47	5 47	5 46	5 46	5 46	5 46	5 46	5 46	5 46	5 47	5 47	5 48	5 48	5 49	5 51	5 52	5 54	5 57	6 01	6 06	R.	7
	S.	5 56	5 55	5 54	5 52	5 51	5 50	5 49	5 47	5 46	5 45	5 44	5 43	5 42	5 41	5 41	5 40	5 40	5 39	5 39	5 40	5 40	5 41	5 43	5 46	5 50	S.	
8	R.	5 48	5 48	5 48	5 47	5 47	5 47	5 47	5 47	5 47	5 47	5 47	5 47	5 47	5 47	5 48	5 48	5 49	5 49	5 50	5 52	5 54	5 56	5 58	6 02	6 08	R.	8
	S.	5 56	5 55	5 54	5 52	5 51	5 50	5 48	5 47	5 46	5 45	5 44	5 43	5 41	5 40	5 40	5 39	5 39	5 38	5 38	5 39	5 39	5 40	5 41	5 44	5 49	S.	
9	R.	5 48	5 48	5 48	5 48	5 48	5 47	5 47	5 47	5 48	5 48	5 48	5 48	5 48	5 48	5 49	5 49	5 50	5 51	5 52	5 53	5 55	5 57	6 00	6 04	6 10	R.	9
	S.	5 56	5 56	5 54	5 52	5 51	5 49	5 48	5 46	5 45	5 44	5 43	5 42	5 40	5 39	5 39	5 38	5 37	5 37	5 37	5 37	5 37	5 38	5 39	5 42	5 47	S.	
10	R.	5 48	5 48	5 48	5 48	5 48	5 48	5 48	5 48	5 48	5 48	5 48	5 48	5 49	5 49	5 50	5 50	5 51	5 52	5 53	5 55	5 57	5 59	6 02	6 06	6 11	R.	10
	S.	5 56	5 55	5 54	5 52	5 51	5 49	5 48	5 46	5 44	5 43	5 42	5 41	5 40	5 39	5 38	5 37	5 36	5 36	5 36	5 36	5 36	5 37	5 38	5 41	5 45	S.	
11	R.	5 48	5 48	5 48	5 48	5 48	5 48	5 48	5 48	5 49	5 49	5 49	5 49	5 50	5 50	5 51	5 51	5 52	5 53	5 54	5 56	5 58	6 00	6 03	6 08	6 13	R.	11
	S.	5 56	5 55	5 53	5 52	5 50	5 48	5 47	5 45	5 44	5 43	5 41	5 40	5 39	5 38	5 37	5 36	5 35	5 35	5 34	5 34	5 34	5 35	5 36	5 39	5 43	S.	
12	R.	5 48	5 48	5 48	5 48	5 49	5 49	5 49	5 49	5 49	5 49	5 50	5 50	5 51	5 51	5 52	5 52	5 53	5 54	5 56	5 58	6 00	6 02	6 05	6 09	6 15	R.	12
	S.	5 56	5 55	5 53	5 51	5 50	5 48	5 47	5 45	5 43	5 42	5 41	5 39	5 38	5 37	5 36	5 35	5 34	5 33	5 33	5 33	5 33	5 34	5 35	5 37	5 42	S.	
13	R.	5 48	5 48	5 49	5 49	5 49	5 49	5 49	5 49	5 50	5 50	5 51	5 51	5 52	5 52	5 53	5 54	5 55	5 56	5 57	5 59	6 01	6 04	6 07	6 11	6 17	R.	13
	S.	5 56	5 54	5 53	5 51	5 49	5 48	5 46	5 44	5 43	5 41	5 40	5 38	5 37	5 36	5 35	5 34	5 33	5 32	5 31	5 31	5 31	5 32	5 33	5 35	5 40	S.	
14	R.	5 48	5 48	5 49	5 49	5 49	5 49	5 50	5 50	5 50	5 51	5 51	5 52	5 52	5 53	5 54	5 55	5 56	5 57	5 59	6 01	6 03	6 05	6 08	6 13	6 18	R.	14
	S.	5 56	5 54	5 53	5 51	5 49	5 47	5 46	5 44	5 42	5 41	5 39	5 38	5 36	5 35	5 34	5 33	5 32	5 31	5 30	5 30	5 30	5 30	5 31	5 34	5 38	S.	
15	R.	5 48	5 48	5 49	5 49	5 50	5 50	5 50	5 50	5 51	5 51	5 52	5 52	5 53	5 54	5 55	5 56	5 57	5 58	6 00	6 02	6 04	6 07	6 10	6 15	6 20	R.	15
	S.	5 56	5 54	5 52	5 50	5 49	5 47	5 45	5 43	5 42	5 40	5 39	5 37	5 35	5 34	5 33	5 32	5 30	5 29	5 28	5 28	5 28	5 29	5 29	5 32	5 36	S.	
16	R.	5 48	5 48	5 49	5 49	5 50	5 50	5 51	5 51	5 51	5 52	5 53	5 53	5 54	5 55	5 56	5 57	5 58	6 00	6 02	6 04	6 06	6 08	6 12	6 17	6 22	R.	16
	S.	5 56	5 54	5 52	5 50	5 49	5 47	5 45	5 43	5 41	5 40	5 38	5 36	5 34	5 33	5 32	5 31	5 29	5 28	5 27	5 27	5 27	5 27	5 28	5 30	5 34	S.	
17	R.	5 48	5 48	5 49	5 49	5 50	5 50	5 51	5 51	5 52	5 53	5 53	5 54	5 55	5 56	5 57	5 58	6 00	6 01	6 03	6 05	6 08	6 10	6 14	6 19	6 24	R.	17
	S.	5 56	5 54	5 52	5 50	5 48	5 46	5 44	5 42	5 40	5 39	5 37	5 35	5 33	5 32	5 30	5 29	5 28	5 26	5 26	5 25	5 25	5 25	5 26	5 28	5 32	S.	
18	R.	5 48	5 48	5 49	5 49	5 50	5 50	5 51	5 52	5 53	5 53	5 54	5 55	5 56	5 57	5 58	5 59	6 01	6 02	6 04	6 07	6 09	6 12	6 15	6 20	6 26	R.	18
	S.	5 56	5 54	5 52	5 50	5 48	5 46	5 44	5 42	5 40	5 38	5 36	5 34	5 32	5 31	5 29	5 28	5 27	5 25	5 24	5 24	5 23	5 24	5 24	5 26	5 30	S.	
19	R.	5 48	5 48	5 49	5 50	5 51	5 51	5 52	5 52	5 53	5 54	5 55	5 56	5 57	5 58	5 59	6 01	6 02	6 04	6 06	6 08	6 11	6 14	6 17	6 22	6 28	R.	19
	S.	5 56	5 54	5 52	5 50	5 48	5 46	5 44	5 41	5 39	5 37	5 35	5 33	5 31	5 30	5 28	5 27	5 25	5 24	5 23	5 22	5 22	5 22	5 22	5 24	5 28	S.	
20	R.	5 48	5 48	5 49	5 50	5 51	5 51	5 52	5 53	5 54	5 55	5 56	5 57	5 58	5 59	6 00	6 02	6 03	6 05	6 07	6 10	6 12	6 15	6 19	6 24	6 30	R.	20
	S.	5 56	5 54	5 52	5 50	5 48	5 45	5 43	5 41	5 39	5 37	5 35	5 33	5 31	5 29	5 27	5 26	5 24	5 23	5 21	5 21	5 20	5 20	5 20	5 22	5 26	S.	

TABLE 10.

Mean Time of Sun's Visible Rising and Setting.

North Latitude: 21° to 40°—September 23 to December 22.

[R—Local mean time of sun's visible rising. S—Local mean time of sun's visible setting.]

Lat. N.	Approx. date.	SEPTEMBER.			OCTOBER.												NOVEMBER.							DECEMBER.			Approx. date.	Lat. N.
		23	26	28	1	4	6	9	11	14	17	19	22	25	28	31	3	6	10	14	17	22	27	3	11	22		
	Dec. S.	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	13°	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	23° 27′	Dec. S.	
°		h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.		°
21	R.	5 48	5 49	5 50	5 50	5 51	5 52	5 53	5 53	5 55	5 56	5 57	5 58	5 59	6 00	6 01	6 03	6 05	6 06	6 09	6 11	6 14	6 17	6 21	6 26	6 32	R.	21
	S.	5 56	5 54	5 52	5 49	5 47	5 45	5 43	5 40	5 38	5 36	5 34	5 32	5 30	5 28	5 26	5 25	5 23	5 21	5 20	5 19	5 18	5 18	5 18	5 20	5 24	S.	
22	R.	5 48	5 49	5 50	5 50	5 51	5 52	5 53	5 54	5 55	5 56	5 57	5 58	6 00	6 01	6 02	6 04	6 06	6 08	6 10	6 13	6 16	6 19	6 23	6 28	6 31	R.	22
	S.	5 56	5 54	5 52	5 49	5 47	5 45	5 42	5 40	5 37	5 35	5 33	5 31	5 29	5 27	5 25	5 24	5 22	5 20	5 18	5 18	5 17	5 17	5 17	5 18	5 22	S.	
23	R.	5 48	5 49	5 50	5 51	5 52	5 53	5 54	5 55	5 56	5 57	5 58	5 59	6 01	6 02	6 04	6 05	6 07	6 09	6 12	6 14	6 17	6 21	6 25	6 30	6 36	R.	23
	S.	5 56	5 54	5 52	5 49	5 47	5 44	5 42	5 39	5 37	5 35	5 32	5 30	5 28	5 26	5 24	5 22	5 20	5 18	5 17	5 16	5 15	5 15	5 15	5 16	5 20	S.	
24	R.	5 48	5 49	5 50	5 51	5 52	5 53	5 54	5 55	5 56	5 57	5 59	6 00	6 02	6 03	6 05	6 07	6 09	6 11	6 13	6 16	6 19	6 22	6 27	6 32	6 38	R.	24
	S.	5 56	5 54	5 52	5 49	5 46	5 44	5 41	5 39	5 36	5 34	5 32	5 29	5 27	5 25	5 23	5 21	5 19	5 17	5 15	5 15	5 14	5 13	5 13	5 14	5 18	S.	
25	R.	5 48	5 49	5 50	5 51	5 52	5 53	5 55	5 56	5 57	5 58	6 00	6 01	6 03	6 04	6 06	6 08	6 10	6 12	6 15	6 18	6 21	6 24	6 29	6 34	6 40	R.	25
	S.	5 56	5 54	5 51	5 48	5 46	5 43	5 41	5 38	5 35	5 33	5 31	5 28	5 26	5 23	5 21	5 19	5 17	5 15	5 14	5 13	5 12	5 11	5 11	5 12	5 16	S.	
26	R.	5 48	5 49	5 50	5 51	5 53	5 54	5 55	5 56	5 58	5 59	6 00	6 02	6 04	6 05	6 07	6 09	6 11	6 13	6 16	6 19	6 22	6 26	6 31	6 36	6 42	R.	26
	S.	5 56	5 54	5 51	5 48	5 46	5 43	5 40	5 37	5 35	5 33	5 30	5 28	5 25	5 22	5 20	5 18	5 16	5 14	5 12	5 11	5 10	5 09	5 09	5 10	5 14	S.	
27	R.	5 48	5 49	5 50	5 51	5 53	5 54	5 56	5 57	5 58	6 00	6 01	6 03	6 05	6 06	6 08	6 10	6 13	6 15	6 18	6 21	6 24	6 28	6 33	6 39	6 45	R.	27
	S.	5 57	5 54	5 51	5 48	5 45	5 42	5 40	5 37	5 34	5 32	5 29	5 27	5 24	5 21	5 19	5 17	5 15	5 13	5 11	5 10	5 08	5 07	5 07	5 08	5 12	S.	
28	R.	5 48	5 49	5 51	5 52	5 53	5 54	5 56	5 57	5 59	6 00	6 02	6 04	6 06	6 07	6 09	6 12	6 14	6 16	6 19	6 23	6 26	6 30	6 35	6 41	6 47	R.	28
	S.	5 57	5 54	5 51	5 48	5 45	5 42	5 39	5 36	5 34	5 31	5 28	5 26	5 23	5 20	5 18	5 16	5 13	5 11	5 09	5 08	5 06	5 05	5 05	5 06	5 10	S.	
29	R.	5 48	5 49	5 51	5 52	5 54	5 55	5 57	5 58	6 00	6 01	6 03	6 05	6 07	6 09	6 11	6 13	6 16	6 18	6 21	6 25	6 28	6 32	6 37	6 43	6 49	R.	29
	S.	5 57	5 54	5 51	5 48	5 45	5 42	5 39	5 36	5 33	5 30	5 27	5 25	5 22	5 19	5 17	5 14	5 12	5 09	5 07	5 06	5 04	5 03	5 03	5 04	5 07	S.	
30	R.	5 48	5 49	5 51	5 52	5 54	5 55	5 57	5 58	6 00	6 02	6 04	6 06	6 08	6 10	6 12	6 15	6 17	6 20	6 23	6 26	6 30	6 34	6 39	6 45	6 51	R.	30
	S.	5 57	5 54	5 51	5 48	5 45	5 41	5 38	5 35	5 32	5 30	5 27	5 24	5 21	5 18	5 15	5 13	5 10	5 08	5 06	5 04	5 02	5 01	5 01	5 02	5 05	S.	
31	R.	5 48	5 49	5 51	5 52	5 54	5 56	5 58	5 59	6 01	6 03	6 05	6 07	6 09	6 11	6 14	6 16	6 19	6 21	6 24	6 28	6 32	6 36	6 41	6 47	6 54	R.	31
	S.	5 57	5 54	5 51	5 47	5 44	5 41	5 38	5 34	5 31	5 29	5 26	5 23	5 20	5 17	5 14	5 11	5 09	5 06	5 04	5 02	5 00	4 59	4 58	4 59	5 03	S.	
32	R.	5 48	5 49	5 51	5 52	5 54	5 56	5 58	6 00	6 02	6 04	6 06	6 08	6 10	6 12	6 15	6 17	6 20	6 23	6 26	6 30	6 34	6 38	6 43	6 50	6 56	R.	32
	S.	5 57	5 54	5 51	5 47	5 43	5 40	5 37	5 34	5 31	5 28	5 25	5 22	5 19	5 16	5 13	5 10	5 07	5 05	5 02	5 00	4 58	4 57	4 56	4 57	5 00	S.	
33	R.	5 48	5 49	5 51	5 53	5 55	5 57	5 59	6 01	6 03	6 05	6 07	6 09	6 11	6 13	6 16	6 19	6 22	6 25	6 28	6 32	6 36	6 41	6 46	6 52	6 59	R.	33
	S.	5 57	5 53	5 50	5 47	5 43	5 40	5 37	5 33	5 30	5 27	5 24	5 21	5 17	5 14	5 11	5 09	5 06	5 03	5 00	4 58	4 56	4 55	4 54	4 54	4 58	S.	
34	R.	5 48	5 49	5 51	5 53	5 55	5 57	5 59	6 01	6 03	6 05	6 08	6 10	6 12	6 15	6 18	6 20	6 23	6 26	6 30	6 34	6 38	6 43	6 48	6 55	7 01	R.	34
	S.	5 57	5 53	5 50	5 47	5 43	5 39	5 36	5 33	5 29	5 26	5 23	5 20	5 16	5 13	5 10	5 07	5 04	5 01	4 59	4 57	4 54	4 53	4 52	4 52	4 55	S.	
35	R.	5 48	5 50	5 52	5 53	5 55	5 58	6 00	6 02	6 04	6 06	6 09	6 11	6 14	6 16	6 19	6 22	6 25	6 28	6 32	6 36	6 40	6 45	6 50	6 57	7 04	R.	35
	S.	5 57	5 53	5 50	5 46	5 42	5 39	5 36	5 32	5 28	5 25	5 22	5 18	5 15	5 11	5 08	5 05	5 02	4 59	4 57	4 55	4 52	4 51	4 49	4 49	4 53	S.	
36	R.	5 48	5 50	5 52	5 54	5 56	5 58	6 00	6 02	6 05	6 07	6 10	6 12	6 15	6 17	6 21	6 24	6 27	6 30	6 34	6 38	6 42	6 47	6 53	7 00	7 06	R.	36
	S.	5 57	5 53	5 50	5 46	5 42	5 38	5 35	5 31	5 28	5 24	5 21	5 17	5 14	5 10	5 07	5 04	5 01	4 58	4 55	4 53	4 50	4 48	4 47	4 47	4 50	S.	
37	R.	5 48	5 50	5 52	5 54	5 56	5 59	6 01	6 03	6 06	6 08	6 11	6 13	6 16	6 19	6 22	6 25	6 29	6 32	6 36	6 40	6 45	6 50	6 55	7 02	7 09	R.	37
	S.	5 57	5 53	5 49	5 45	5 41	5 38	5 34	5 30	5 27	5 23	5 20	5 16	5 12	5 09	5 05	5 02	4 59	4 56	4 53	4 50	4 48	4 46	4 44	4 44	4 47	S.	
38	R.	5 47	5 50	5 52	5 54	5 56	5 59	6 02	6 04	6 06	6 09	6 12	6 14	6 17	6 20	6 24	6 27	6 30	6 34	6 38	6 42	6 47	6 52	6 58	7 05	7 12	R.	38
	S.	5 57	5 53	5 49	5 45	5 41	5 37	5 34	5 30	5 26	5 22	5 19	5 15	5 11	5 07	5 04	5 01	4 57	4 54	4 51	4 48	4 45	4 43	4 42	4 41	4 44	S.	
39	R.	5 47	5 50	5 52	5 54	5 57	6 00	6 02	6 05	6 07	6 10	6 13	6 16	6 19	6 22	6 25	6 29	6 32	6 36	6 40	6 45	6 50	6 55	7 01	7 08	7 15	R.	39
	S.	5 57	5 53	5 49	5 45	5 41	5 37	5 33	5 29	5 25	5 21	5 18	5 14	5 10	5 06	5 02	4 59	4 55	4 52	4 48	4 46	4 43	4 41	4 39	4 38	4 41	S.	
40	R.	5 47	5 50	5 52	5 55	5 57	6 00	6 03	6 06	6 08	6 11	6 14	6 17	6 20	6 23	6 27	6 30	6 34	6 38	6 42	6 47	6 52	6 57	7 03	7 11	7 18	R.	40
	S.	5 57	5 53	5 49	5 45	5 40	5 36	5 32	5 28	5 24	5 20	5 17	5 13	5 08	5 04	5 01	4 57	4 53	4 50	4 46	4 43	4 40	4 38	4 36	4 35	4 38	S.	

TABLE 10.

Mean Time of Sun's Visible Rising and Setting.

North Latitude: 41° to 60°—September 23 to December 22.

[R—Local mean time of sun's visible rising. S—Local mean time of sun's visible setting.]

Lat. N.	Approx. date.	SEPTEMBER.			OCTOBER.												NOVEMBER.							DECEMBER.			Approx. date.	Lat. N.
		23	26	28	1	4	6	9	11	14	17	19	22	25	28	31	3	6	10	14	17	22	27	3	11	22		
	Dec. S.	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	13°	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	23° 27′	Dec. S.	
°		h. m.	h. m.	h. m.	h. m.	h. m	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.		°
41	R.	5 47	5 50	5 53	5 55	5 58	6 01	6 04	6 06	6 09	6 12	6 15	6 18	6 22	6 25	6 29	6 32	6 36	6 40	6 45	6 50	6 55	7 00	7 06	7 14	7 21	R.	41
	S.	5 57	5 53	5 49	5 44	5 40	5 36	5 32	5 27	5 23	5 19	5 15	5 11	5 07	5 03	4 59	4 55	4 51	4 47	4 44	4 41	4 38	4 35	4 33	4 32	4 35	S.	
42	R.	5 47	5 50	5 53	5 55	5 58	6 01	6 04	6 07	6 10	6 13	6 16	6 20	6 23	6 26	6 30	6 34	6 38	6 42	6 47	6 52	6 57	7 03	7 09	7 17	7 24	R.	42
	S.	5 57	5 53	5 49	5 44	5 39	5 35	5 31	5 27	5 22	5 18	5 14	5 10	5 06	5 01	4 57	4 53	4 49	4 45	4 42	4 39	4 35	4 33	4 30	4 29	4 32	S.	
43	R.	5 47	5 50	5 53	5 56	5 59	6 02	6 05	6 08	6 11	6 14	6 18	6 21	6 25	6 28	6 32	6 36	6 40	6 44	6 49	6 54	7 00	7 06	7 12	7 20	7 28	R.	43
	S.	5 57	5 53	5 48	5 44	5 39	5 35	5 30	5 26	5 21	5 17	5 13	5 08	5 04	4 59	4 55	4 51	4 47	4 43	4 39	4 36	4 33	4 30	4 27	4 26	4 29	S.	
44	R.	5 47	5 50	5 53	5 56	5 59	6 02	6 06	6 09	6 12	6 16	6 19	6 23	6 26	6 30	6 34	6 38	6 42	6 47	6 52	6 57	7 03	7 09	7 15	7 24	7 31	R.	44
	S.	5 58	5 53	5 48	5 44	5 39	5 34	5 30	5 25	5 20	5 16	5 11	5 07	5 02	4 58	4 54	4 49	4 45	4 41	4 37	4 33	4 30	4 27	4 24	4 23	4 25	S.	
45	R.	5 47	5 50	5 53	5 56	5 59	6 03	6 06	6 09	6 13	6 17	6 20	6 24	6 28	6 31	6 36	6 40	6 45	6 49	6 54	7 00	7 06	7 12	7 19	7 27	7 35	R.	45
	S.	5 58	5 53	5 48	5 43	5 38	5 34	5 29	5 24	5 19	5 15	5 10	5 06	5 01	4 56	4 52	4 47	4 43	4 38	4 34	4 31	4 27	4 24	4 21	4 19	4 22	S.	
46	R.	5 47	5 50	5 53	5 56	6 00	6 03	6 07	6 10	6 14	6 18	6 22	6 26	6 29	6 33	6 38	6 42	6 47	6 52	6 57	7 03	7 09	7 15	7 22	7 31	7 38	R.	46
	S.	5 58	5 53	5 48	5 43	5 38	5 33	5 28	5 23	5 18	5 14	5 09	5 04	4 59	4 54	4 50	4 45	4 41	4 36	4 32	4 28	4 24	4 20	4 17	4 16	4 18	S.	
47	R.	5 47	5 50	5 54	5 57	6 01	6 04	6 08	6 11	6 15	6 19	6 23	6 27	6 31	6 35	6 40	6 44	6 49	6 54	7 00	7 06	7 12	7 19	7 26	7 35	7 42	R.	47
	S.	5 58	5 53	5 48	5 43	5 38	5 33	5 28	5 22	5 17	5 12	5 07	5 02	4 57	4 53	4 48	4 43	4 38	4 33	4 29	4 25	4 21	4 17	4 14	4 12	4 14	S.	
48	R.	5 47	5 50	5 54	5 57	6 01	6 05	6 09	6 12	6 16	6 20	6 25	6 29	6 33	6 37	6 42	6 47	6 52	6 57	7 03	7 09	7 15	7 22	7 30	7 39	7 46	R.	48
	S.	5 58	5 53	5 48	5 42	5 37	5 32	5 27	5 21	5 16	5 11	5 06	5 01	4 56	4 51	4 46	4 41	4 36	4 31	4 26	4 22	4 17	4 13	4 10	4 08	4 10	S.	
49	R.	5 47	5 50	5 54	5 58	6 02	6 05	6 09	6 13	6 18	6 22	6 26	6 30	6 35	6 39	6 44	6 49	6 55	7 00	7 06	7 12	7 19	7 26	7 34	7 43	7 51	R.	49
	S.	5 58	5 53	5 48	5 42	5 37	5 31	5 26	5 20	5 15	5 10	5 04	4 59	4 54	4 49	4 43	4 38	4 33	4 28	4 23	4 18	4 14	4 10	4 06	4 04	4 06	S.	
50	R.	5 46	5 50	5 54	5 58	6 02	6 06	6 10	6 14	6 19	6 23	6 28	6 32	6 37	6 41	6 47	6 52	6 57	7 03	7 09	7 16	7 23	7 30	7 38	7 47	7 55	R.	50
	S.	5 58	5 53	5 47	5 41	5 36	5 30	5 25	5 19	5 14	5 08	5 03	4 57	4 52	4 46	4 41	4 36	4 30	4 25	4 20	4 15	4 10	4 06	4 02	3 59	4 01	S.	
51	R.	5 46	5 50	5 55	5 59	6 03	6 07	6 11	6 16	6 20	6 25	6 29	6 34	6 39	6 44	6 49	6 55	7 00	7 06	7 12	7 19	7 26	7 34	7 42	7 52	8 00	R.	51
	S.	5 58	5 52	5 47	5 41	5 35	5 29	5 24	5 18	5 12	5 07	5 01	4 56	4 50	4 44	4 38	4 33	4 27	4 22	4 16	4 11	4 06	4 02	3 57	3 55	3 56	S.	
52	R.	5 46	5 50	5 55	5 59	6 04	6 08	6 12	6 17	6 21	6 26	6 31	6 36	6 41	6 46	6 52	6 57	7 03	7 09	7 16	7 23	7 30	7 38	7 47	7 57	8 05	R.	52
	S.	5 58	5 52	5 47	5 41	5 35	5 29	5 23	5 17	5 11	5 05	5 00	4 54	4 48	4 42	4 36	4 30	4 24	4 18	4 13	4 08	4 02	3 57	3 53	3 50	3 51	S.	
53	R.	5 46	5 50	5 55	5 59	6 04	6 09	6 13	6 18	6 23	6 28	6 33	6 38	6 43	6 48	6 54	7 00	7 06	7 13	7 19	7 27	7 35	7 43	7 52	8 02	8 11	R.	53
	S.	5 58	5 52	5 46	5 40	5 34	5 28	5 22	5 16	5 10	5 04	4 58	4 52	4 45	4 39	4 33	4 27	4 21	4 15	4 09	4 04	3 58	3 53	3 48	3 44	3 46	S.	
54	R.	5 46	5 50	5 55	6 00	6 05	6 09	6 14	6 19	6 24	6 29	6 35	6 40	6 45	6 51	6 57	7 03	7 10	7 16	7 23	7 31	7 39	7 48	7 57	8 08	8 16	R.	54
	S.	5 59	5 52	5 46	5 40	5 34	5 27	5 21	5 15	5 08	5 02	4 56	4 50	4 43	4 37	4 30	4 24	4 18	4 11	4 05	4 00	3 54	3 48	3 43	3 39	3 40	S.	
55	R.	5 46	5 50	5 55	6 00	6 05	6 10	6 15	6 20	6 26	6 31	6 37	6 42	6 48	6 54	7 00	7 07	7 13	7 20	7 27	7 35	7 44	7 53	8 02	8 13	8 22	R.	55
	S.	5 59	5 52	5 46	5 39	5 33	5 26	5 20	5 13	5 07	5 00	4 54	4 47	4 41	4 34	4 27	4 21	4 14	4 08	4 01	3 55	3 49	3 43	3 37	3 33	3 34	S.	
56	R.	5 45	5 50	5 56	6 01	6 06	6 11	6 17	6 22	6 27	6 33	6 39	6 45	6 51	6 57	7 03	7 10	7 17	7 24	7 32	7 40	7 49	7 58	8 08	8 20	8 29	R.	56
	S.	5 59	5 52	5 46	5 39	5 32	5 25	5 19	5 12	5 05	4 58	4 52	4 45	4 38	4 31	4 24	4 17	4 11	4 04	3 57	3 50	3 44	3 37	3 31	3 27	3 27	S.	
57	R.	5 45	5 50	5 56	6 01	6 06	6 12	6 18	6 23	6 29	6 35	6 41	6 47	6 53	7 00	7 07	7 14	7 21	7 28	7 36	7 45	7 54	8 04	8 14	8 27	8 36	R.	57
	S.	5 59	5 52	5 45	5 38	5 31	5 24	5 17	5 10	5 03	4 56	4 49	4 42	4 35	4 28	4 21	4 14	4 07	3 59	3 52	3 45	3 38	3 31	3 25	3 20	3 20	S.	
58	R.	5 45	5 50	5 56	6 02	6 07	6 13	6 19	6 25	6 31	6 37	6 43	6 50	6 56	7 03	7 10	7 17	7 25	7 33	7 41	7 50	8 00	8 10	8 21	8 34	8 44	R.	58
	S.	5 59	5 52	5 45	5 38	5 31	5 23	5 16	5 09	5 02	4 54	4 47	4 40	4 32	4 25	4 17	4 10	4 03	3 55	3 47	3 40	3 33	3 25	3 18	3 13	3 13	S.	
59	R.	5 45	5 51	5 57	6 02	6 08	6 14	6 21	6 27	6 33	6 39	6 46	6 52	6 59	7 06	7 14	7 21	7 29	7 38	7 47	7 56	8 06	8 17	8 28	8 42	8 52	R.	59
	S.	6 00	5 52	5 45	5 37	5 30	5 22	5 15	5 07	5 00	4 52	4 45	4 37	4 29	4 21	4 14	4 06	3 58	3 50	3 42	3 35	3 27	3 19	3 11	3 05	3 05	S.	
60	R.	5 45	5 51	5 57	6 03	6 09	6 16	6 22	6 28	6 35	6 42	6 48	6 55	7 02	7 10	7 18	7 26	7 34	7 43	7 53	8 02	8 13	8 24	8 36	8 51	9 01	R.	60
	S.	6 00	5 52	5 44	5 36	5 29	5 21	5 13	5 05	4 58	4 50	4 42	4 34	4 26	4 18	4 10	4 02	3 53	3 45	3 36	3 28	3 20	3 12	3 03	2 56	2 56	S.	

TABLE 10.

Mean Time of Sun's Visible Rising and Setting.

North Latitude: 0° to 20°—December 22 to March 21.

[R=Local mean time of sun's visible rising. S=Local mean time of sun's visible setting.]

Lat. N.	Approx. date.	DECEMBER.	JANUARY.						FEBRUARY.									MARCH.									Approx. date.	Lat. N.
		22	2	10	16	21	25	29	2	5	9	12	15	18	20	23	26	1	3	6	8	11	13	16	18	21		
	Dec. S.	23° 27′	23°	22°	21°	20°	19°	18°	17°	16°	15°	14°	13°	12°	11°	10°	9°	8°	7°	6°	5°	4°	3°	2°	1°	0°	Dec. S.	
°		h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.		°
0	R.	5 54	6 00	6 04	6 06	6 07	6 08	6 09	6 10	6 10	6 10	6 10	6 10	6 10	6 10	6 10	6 09	6 09	6 08	6 08	6 07	6 06	6 06	6 05	6 04	6 04	R.	0
	S.	6 02	6 08	6 12	6 14	6 15	6 16	6 17	6 18	6 18	6 18	6 18	6 18	6 18	6 18	6 18	6 17	6 17	6 16	6 16	6 15	6 14	6 14	6 13	6 12	6 11	S.	
1	R.	5 56	6 01	6 05	6 07	6 09	6 10	6 11	6 11	6 12	6 11	6 11	6 11	6 11	6 11	6 11	6 10	6 10	6 09	6 08	6 08	6 07	6 06	6 05	6 05	6 04	R.	1
	S.	6 01	6 06	6 10	6 12	6 14	6 15	6 16	6 16	6 17	6 17	6 17	6 17	6 17	6 17	6 17	6 16	6 16	6 16	6 15	6 15	6 14	6 13	6 12	6 12	6 11	S.	
2	R.	5 57	6 03	6 07	6 09	6 10	6 11	6 12	6 12	6 13	6 12	6 12	6 12	6 12	6 11	6 11	6 11	6 10	6 09	6 09	6 08	6 07	6 06	6 05	6 05	6 04	R.	2
	S.	5 59	6 05	6 09	6 11	6 12	6 14	6 15	6 15	6 16	6 16	6 16	6 17	6 17	6 16	6 16	6 16	6 15	6 15	6 15	6 15	6 14	6 13	6 12	6 12	6 11	S.	
3	R.	5 59	6 04	6 08	6 10	6 12	6 12	6 13	6 13	6 14	6 13	6 13	6 13	6 13	6 12	6 12	6 11	6 11	6 10	6 09	6 08	6 07	6 06	6 05	6 05	6 04	R.	3
	S.	5 57	6 03	6 07	6 09	6 11	6 12	6 13	6 14	6 15	6 15	6 15	6 16	6 16	6 16	6 16	6 15	6 15	6 15	6 14	6 14	6 13	6 13	6 12	6 12	6 11	S.	
4	R.	6 01	6 06	6 10	6 12	6 13	6 14	6 14	6 14	6 15	6 14	6 14	6 14	6 14	6 13	6 12	6 12	6 11	6 10	6 09	6 08	6 07	6 07	6 06	6 05	6 04	R.	4
	S.	5 56	6 02	6 06	6 08	6 09	6 11	6 12	6 13	6 14	6 14	6 14	6 15	6 15	6 15	6 15	6 15	6 14	6 14	6 14	6 14	6 13	6 13	6 12	6 12	6 11	S.	
5	R.	6 03	6 08	6 12	6 13	6 14	6 15	6 16	6 16	6 16	6 16	6 15	6 15	6 15	6 14	6 13	6 12	6 12	6 11	6 10	6 09	6 08	6 07	6 06	6 05	6 04	R.	5
	S.	5 54	6 00	6 04	6 06	6 08	6 09	6 11	6 12	6 12	6 13	6 13	6 14	6 14	6 14	6 14	6 14	6 14	6 14	6 14	6 14	6 13	6 13	6 12	6 12	6 11	S.	
6	R.	6 04	6 09	6 13	6 15	6 16	6 16	6 17	6 17	6 17	6 17	6 16	6 16	6 15	6 14	6 14	6 13	6 12	6 11	6 10	6 09	6 08	6 07	6 06	6 05	6 03	R.	6
	S.	5 52	5 58	6 02	6 05	6 07	6 08	6 10	6 11	6 11	6 12	6 12	6 13	6 13	6 13	6 14	6 14	6 13	6 13	6 13	6 13	6 13	6 13	6 12	6 12	6 11	S.	
7	R.	6 06	6 11	6 15	6 16	6 17	6 18	6 18	6 18	6 18	6 18	6 17	6 17	6 16	6 15	6 15	6 14	6 13	6 12	6 11	6 10	6 08	6 07	6 06	6 05	6 03	R.	7
	S.	5 50	5 56	6 01	6 03	6 05	6 07	6 08	6 09	6 10	6 11	6 11	6 12	6 12	6 12	6 13	6 13	6 13	6 13	6 13	6 13	6 12	6 12	6 12	6 12	6 11	S.	
8	R.	6 08	6 13	6 16	6 18	6 19	6 19	6 19	6 19	6 19	6 19	6 18	6 18	6 17	6 16	6 15	6 14	6 13	6 12	6 11	6 10	6 08	6 07	6 06	6 05	6 03	R.	8
	S.	5 49	5 55	5 59	6 02	6 04	6 06	6 07	6 08	6 09	6 10	6 10	6 11	6 11	6 12	6 12	6 12	6 12	6 12	6 13	6 13	6 12	6 12	6 12	6 12	6 11	S.	
9	R.	6 10	6 15	6 18	6 19	6 20	6 20	6 21	6 21	6 21	6 20	6 19	6 19	6 18	6 17	6 16	6 15	6 14	6 13	6 11	6 10	6 09	6 07	6 06	6 05	6 03	R.	9
	S.	5 47	5 53	5 57	6 00	6 02	6 04	6 06	6 07	6 08	6 09	6 09	6 10	6 10	6 11	6 11	6 11	6 11	6 12	6 12	6 12	6 12	6 12	6 12	6 12	6 11	S.	
10	R.	6 11	6 16	6 20	6 21	6 22	6 22	6 22	6 22	6 22	6 21	6 20	6 19	6 19	6 18	6 17	6 16	6 15	6 13	6 12	6 11	6 09	6 07	6 06	6 05	6 03	R.	10
	S.	5 45	5 51	5 56	5 59	6 01	6 03	6 05	6 06	6 07	6 08	6 08	6 09	6 10	6 10	6 11	6 11	6 11	6 11	6 12	6 12	6 12	6 12	6 12	6 12	6 11	S.	
11	R.	6 13	6 18	6 21	6 22	6 23	6 23	6 23	6 23	6 23	6 22	6 21	6 20	6 20	6 19	6 18	6 16	6 15	6 14	6 12	6 11	6 09	6 08	6 06	6 05	6 03	R.	11
	S.	5 43	5 49	5 54	5 57	5 59	6 01	6 03	6 05	6 06	6 07	6 07	6 08	6 08	6 09	6 10	6 10	6 10	6 11	6 11	6 11	6 11	6 12	6 12	6 12	6 11	S.	
12	R.	6 15	6 20	6 23	6 24	6 25	6 25	6 25	6 24	6 24	6 23	6 22	6 21	6 21	6 19	6 18	6 17	6 16	6 14	6 13	6 11	6 10	6 08	6 06	6 05	6 03	R.	12
	S.	5 42	5 48	5 53	5 56	5 58	6 00	6 02	6 03	6 05	6 06	6 06	6 07	6 08	6 08	6 09	6 10	6 10	6 10	6 11	6 11	6 11	6 11	6 11	6 12	6 11	S.	
13	R.	6 17	6 22	6 25	6 26	6 26	6 26	6 26	6 26	6 25	6 24	6 23	6 22	6 22	6 20	6 19	6 18	6 16	6 15	6 13	6 12	6 10	6 09	6 07	6 05	6 03	R.	13
	S.	5 40	5 46	5 51	5 54	5 56	5 58	6 00	6 02	6 03	6 04	6 05	6 06	6 07	6 07	6 08	6 09	6 09	6 10	6 10	6 11	6 11	6 11	6 11	6 11	6 11	S.	
14	R.	6 18	6 23	6 26	6 27	6 28	6 28	6 28	6 27	6 26	6 25	6 24	6 23	6 22	6 21	6 20	6 18	6 17	6 15	6 14	6 12	6 10	6 09	6 07	6 05	6 03	R.	14
	S.	5 38	5 44	5 49	5 52	5 55	5 57	5 59	6 01	6 02	6 03	6 04	6 05	6 06	6 07	6 08	6 08	6 09	6 09	6 10	6 10	6 10	6 11	6 11	6 11	6 11	S.	
15	R.	6 20	6 25	6 28	6 29	6 29	6 29	6 29	6 28	6 28	6 26	6 25	6 24	6 23	6 21	6 20	6 19	6 17	6 16	6 14	6 13	6 11	6 09	6 07	6 05	6 03	R.	15
	S.	5 36	5 42	5 47	5 51	5 53	5 55	5 57	5 59	6 01	6 02	6 03	6 04	6 05	6 06	6 07	6 08	6 08	6 09	6 09	6 10	6 10	6 10	6 11	6 11	6 11	S.	
16	R.	6 22	6 27	6 30	6 30	6 31	6 31	6 30	6 30	6 29	6 27	6 26	6 25	6 24	6 22	6 21	6 19	6 18	6 16	6 15	6 13	6 11	6 09	6 07	6 05	6 03	R.	16
	S.	5 34	5 40	5 46	5 49	5 52	5 54	5 56	5 58	6 00	6 01	6 02	6 03	6 04	6 05	6 06	6 07	6 08	6 08	6 09	6 10	6 10	6 10	6 11	6 11	6 11	S.	
17	R.	6 24	6 29	6 32	6 32	6 33	6 32	6 32	6 31	6 30	6 29	6 28	6 26	6 25	6 23	6 22	6 20	6 19	6 17	6 15	6 13	6 11	6 09	6 07	6 05	6 03	R.	17
	S.	5 32	5 38	5 44	5 47	5 50	5 52	5 55	5 56	5 58	6 00	6 01	6 02	6 03	6 04	6 05	6 06	6 07	6 08	6 08	6 09	6 09	6 10	6 10	6 11	6 11	S.	
18	R.	6 26	6 31	6 33	6 34	6 34	6 34	6 33	6 32	6 31	6 30	6 29	6 27	6 26	6 24	6 23	6 21	6 19	6 17	6 15	6 13	6 11	6 09	6 07	6 05	6 03	R.	18
	S.	5 30	5 37	5 42	5 46	5 48	5 51	5 53	5 55	5 57	5 59	6 00	6 01	6 02	6 03	6 04	6 05	6 06	6 07	6 08	6 09	6 09	6 10	6 10	6 11	6 11	S.	
19	R.	6 28	6 33	6 35	6 36	6 36	6 35	6 35	6 34	6 33	6 31	6 30	6 28	6 27	6 25	6 24	6 22	6 20	6 18	6 16	6 14	6 12	6 10	6 07	6 05	6 03	R.	19
	S.	5 28	5 35	5 40	5 44	5 47	5 49	5 52	5 54	5 56	5 57	5 59	6 00	6 01	6 02	6 04	6 05	6 06	6 06	6 07	6 08	6 09	6 09	6 10	6 10	6 11	S.	
20	R.	6 30	6 35	6 37	6 37	6 37	6 37	6 36	6 35	6 34	6 32	6 31	6 29	6 28	6 26	6 24	6 22	6 20	6 18	6 16	6 14	6 12	6 10	6 07	6 05	6 03	R.	20
	S.	5 26	5 33	5 38	5 42	5 45	5 48	5 50	5 53	5 55	5 56	5 58	5 59	6 01	6 02	6 03	6 04	6 05	6 06	6 07	6 08	6 09	6 10	6 10	6 11	6 11	S.	

TABLE 10.

Mean Time of Sun's Visible Rising and Setting.

North Latitude: 21° to 40°—December 22 to March 21.

[R=Local mean time of sun's visible rising. S=Local mean time of sun's visible setting.]

Lat. N.	Approx. date.	DECEMBER.	JANUARY.						FEBRUARY.									MARCH.									Approx. date.	Lat. N.
		22	2	10	16	21	25	29	2	5	9	12	15	18	20	23	26	1	3	6	8	11	13	16	18	21		
	Dec. S.	23° 27′	23°	22°	21°	20°	19°	18°	17°	16°	15°	14°	13°	12°	11°	10°	9°	8°	7°	6°	5°	4°	3°	2°	1°	0°	Dec. S.	
°		h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.		°
21	R.	6 32	6 37	6 39	6 39	6 39	6 38	6 37	6 36	6 35	6 33	6 32	6 30	6 29	6 27	6 25	6 23	6 21	6 19	6 17	6 15	6 12	6 10	6 08	6 06	6 03	R.	21
	S.	5 24	5 31	5 36	5 40	5 43	5 46	5 49	5 51	5 53	5 55	5 57	5 58	6 00	6 01	6 02	6 03	6 04	6 06	6 07	6 08	6 08	6 09	6 10	6 11	6 11	S.	
22	R.	6 34	6 39	6 41	6 41	6 41	6 40	6 39	6 38	6 36	6 34	6 33	6 31	6 30	6 28	6 26	6 24	6 22	6 19	6 17	6 15	6 12	6 10	6 08	6 06	6 03	R.	22
	S.	5 22	5 29	5 35	5 39	5 42	5 45	5 47	5 50	5 52	5 54	5 56	5 57	5 59	6 00	6 02	6 03	6 04	6 05	6 06	6 08	6 08	6 09	6 10	6 11	6 11	S.	
23	R.	6 36	6 41	6 43	6 43	6 42	6 41	6 41	6 39	6 38	6 36	6 34	6 32	6 31	6 28	6 27	6 24	6 22	6 20	6 18	6 15	6 13	6 10	6 08	6 06	6 03	R.	23
	S.	5 20	5 27	5 33	5 37	5 40	5 43	5 46	5 48	5 51	5 53	5 54	5 56	5 58	5 59	6 01	6 02	6 03	6 05	6 06	6 07	6 08	6 09	6 10	6 11	6 11	S.	
24	R.	6 38	6 43	6 45	6 44	6 44	6 43	6 42	6 41	6 39	6 37	6 35	6 33	6 32	6 29	6 27	6 25	6 23	6 20	6 18	6 16	6 13	6 11	6 08	6 06	6 03	R.	24
	S.	5 18	5 25	5 31	5 35	5 39	5 42	5 44	5 47	5 49	5 51	5 53	5 55	5 57	5 58	6 00	6 02	6 03	6 04	6 05	6 07	6 08	6 09	6 10	6 11	6 11	S.	
25	R.	6 40	6 45	6 47	6 46	6 46	6 45	6 44	6 42	6 41	6 39	6 37	6 35	6 33	6 30	6 28	6 26	6 24	6 21	6 19	6 16	6 13	6 11	6 08	6 06	6 03	R.	25
	S.	5 16	5 23	5 29	5 33	5 37	5 40	5 43	5 45	5 48	5 50	5 52	5 54	5 56	5 57	5 59	6 01	6 02	6 03	6 05	6 06	6 07	6 08	6 09	6 10	6 11	S.	
26	R.	6 42	6 47	6 49	6 48	6 47	6 46	6 45	6 43	6 42	6 40	6 38	6 36	6 34	6 31	6 29	6 26	6 24	6 22	6 19	6 17	6 14	6 11	6 08	6 06	6 03	R.	26
	S.	5 14	5 21	5 27	5 31	5 35	5 38	5 41	5 44	5 47	5 49	5 51	5 53	5 55	5 57	5 59	6 00	6 01	6 03	6 04	6 06	6 07	6 08	6 09	6 10	6 11	S.	
27	R.	6 45	6 49	6 51	6 50	6 49	6 48	6 47	6 45	6 43	6 41	6 39	6 37	6 35	6 32	6 30	6 27	6 25	6 22	6 20	6 17	6 14	6 11	6 08	6 06	6 03	R.	27
	S.	5 12	5 18	5 25	5 29	5 33	5 37	5 40	5 43	5 45	5 48	5 50	5 52	5 54	5 56	5 58	5 59	6 01	6 02	6 04	6 05	6 06	6 08	6 09	6 10	6 11	S.	
28	R.	6 47	6 51	6 53	6 52	6 51	6 50	6 48	6 46	6 45	6 42	6 40	6 38	6 36	6 33	6 31	6 28	6 25	6 23	6 20	6 17	6 14	6 12	6 09	6 06	6 03	R.	28
	S.	5 10	5 16	5 23	5 27	5 31	5 35	5 38	5 41	5 44	5 46	5 49	5 51	5 53	5 55	5 57	5 59	6 00	6 02	6 03	6 05	6 06	6 08	6 09	6 10	6 11	S.	
29	R.	6 49	6 53	6 55	6 54	6 53	6 52	6 50	6 48	6 46	6 44	6 41	6 39	6 37	6 34	6 32	6 29	6 26	6 23	6 21	6 18	6 15	6 12	6 09	6 06	6 03	R.	29
	S.	5 07	5 14	5 21	5 25	5 29	5 33	5 36	5 39	5 42	5 45	5 47	5 50	5 52	5 54	5 56	5 58	5 59	6 01	6 03	6 05	6 06	6 08	6 09	6 10	6 11	S.	
30	R.	6 51	6 55	6 57	6 56	6 55	6 53	6 52	6 50	6 48	6 45	6 43	6 40	6 38	6 35	6 32	6 29	6 27	6 24	6 21	6 18	6 15	6 12	6 09	6 06	6 03	R.	30
	S.	5 05	5 12	5 19	5 23	5 27	5 31	5 35	5 38	5 41	5 43	5 46	5 48	5 51	5 53	5 55	5 57	5 59	6 01	6 02	6 04	6 06	6 08	6 09	6 10	6 12	S.	
31	R.	6 54	6 58	6 59	6 58	6 57	6 55	6 53	6 51	6 49	6 47	6 44	6 41	6 39	6 36	6 33	6 30	6 28	6 25	6 22	6 19	6 15	6 12	6 09	6 06	6 03	R.	31
	S.	5 03	5 10	5 16	5 21	5 25	5 29	5 33	5 36	5 39	5 42	5 44	5 47	5 50	5 52	5 54	5 56	5 58	6 00	6 02	6 04	6 05	6 07	6 09	6 10	6 12	S.	
32	R.	6 56	7 00	7 01	7 00	6 59	6 57	6 55	6 53	6 51	6 48	6 45	6 42	6 40	6 37	6 34	6 31	6 28	6 25	6 22	6 19	6 16	6 12	6 09	6 06	6 03	R.	32
	S.	5 00	5 07	5 14	5 19	5 23	5 27	5 31	5 35	5 38	5 41	5 43	5 46	5 49	5 51	5 53	5 55	5 57	5 59	6 01	6 03	6 05	6 07	6 09	6 10	6 12	S.	
33	R.	6 59	7 03	7 04	7 03	7 01	6 59	6 57	6 55	6 52	6 49	6 47	6 44	6 41	6 38	6 35	6 32	6 29	6 26	6 23	6 20	6 16	6 13	6 09	6 06	6 03	R.	33
	S.	4 58	5 05	5 12	5 17	5 21	5 25	5 29	5 33	5 36	5 39	5 42	5 45	5 47	5 50	5 52	5 54	5 56	5 59	6 01	6 03	6 05	6 07	6 08	6 10	6 12	S.	
34	R.	7 01	7 05	7 06	7 05	7 03	7 01	6 59	6 56	6 54	6 51	6 48	6 45	6 42	6 39	6 36	6 33	6 30	6 26	6 23	6 20	6 16	6 13	6 09	6 06	6 03	R.	34
	S.	4 55	5 02	5 10	5 15	5 19	5 24	5 28	5 31	5 35	5 38	5 40	5 43	5 46	5 49	5 51	5 54	5 56	5 58	6 00	6 02	6 04	6 06	6 08	6 10	6 12	S.	
35	R.	7 04	7 08	7 08	7 07	7 05	7 03	7 01	6 58	6 56	6 53	6 50	6 47	6 44	6 40	6 37	6 34	6 31	6 27	6 24	6 21	6 17	6 13	6 10	6 06	6 03	R.	35
	S.	4 53	5 00	5 07	5 13	5 17	5 22	5 26	5 29	5 33	5 36	5 39	5 42	5 45	5 47	5 50	5 53	5 55	5 57	6 00	6 02	6 04	6 06	6 08	6 10	6 12	S.	
36	R.	7 06	7 10	7 11	7 09	7 07	7 05	7 03	7 00	6 57	6 54	6 51	6 48	6 45	6 41	6 38	6 35	6 31	6 28	6 24	6 21	6 17	6 14	6 10	6 06	6 03	R.	36
	S.	4 50	4 57	5 05	5 10	5 15	5 20	5 24	5 28	5 31	5 34	5 37	5 41	5 44	5 46	5 49	5 52	5 54	5 57	5 59	6 01	6 03	6 06	6 08	6 10	6 12	S.	
37	R.	7 09	7 13	7 13	7 12	7 10	7 07	7 05	7 02	6 59	6 56	6 53	6 49	6 46	6 42	6 39	6 36	6 32	6 29	6 25	6 22	6 18	6 14	6 10	6 06	6 03	R.	37
	S.	4 47	4 55	5 02	5 08	5 13	5 17	5 22	5 26	5 29	5 33	5 36	5 39	5 42	5 45	5 48	5 51	5 53	5 56	5 58	6 01	6 03	6 05	6 07	6 10	6 12	S.	
38	R.	7 12	7 16	7 16	7 14	7 12	7 09	7 07	7 04	7 01	6 57	6 54	6 51	6 47	6 43	6 40	6 36	6 33	6 29	6 26	6 22	6 18	6 14	6 10	6 06	6 02	R.	38
	S.	4 44	4 52	5 00	5 05	5 10	5 15	5 20	5 24	5 28	5 31	5 34	5 38	5 41	5 44	5 47	5 50	5 53	5 55	5 58	6 00	6 03	6 05	6 07	6 10	6 12	S.	
39	R.	7 15	7 19	7 19	7 17	7 15	7 12	7 09	7 06	7 03	6 59	6 56	6 52	6 49	6 45	6 41	6 37	6 34	6 30	6 26	6 23	6 18	6 14	6 10	6 06	6 02	R.	39
	S.	4 41	4 49	4 57	5 03	5 08	5 13	5 17	5 22	5 26	5 29	5 33	5 36	5 40	5 43	5 46	5 49	5 52	5 54	5 57	6 00	6 02	6 05	6 07	6 10	6 12	S.	
40	R.	7 18	7 22	7 21	7 19	7 17	7 14	7 11	7 08	7 05	7 01	6 57	6 54	6 50	6 46	6 42	6 38	6 35	6 31	6 27	6 23	6 19	6 15	6 10	6 06	6 02	R.	40
	S.	4 38	4 46	4 54	5 00	5 05	5 10	5 15	5 20	5 24	5 28	5 31	5 35	5 38	5 41	5 45	5 48	5 51	5 53	5 56	5 59	6 02	6 05	6 07	6 10	6 12	S.	

Mean Time of Sun's Visible Rising and Setting.

North Latitude: 41° to 60°—December 22 to March 21.

[R=Local mean time of sun's visible rising. S=Local mean time of sun's visible setting.]

Lat. N.	Approx. date.	DECEMBER.	JANUARY.						FEBRUARY.									MARCH.									Approx. date.	Lat. N.
		22	2	10	16	21	25	29	2	5	9	12	15	18	20	23	26	1	3	6	8	11	13	16	18	21		
	Dec. S.	23° 27′	23°	22°	21°	20°	19°	18°	17°	16°	15°	14°	13°	12°	11°	10°	9°	8°	7°	6°	5°	4°	3°	2°	1°	0°	Dec. S.	
°		h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.		°
41	R.	7 21	7 25	7 24	7 22	7 20	7 17	7 14	7 10	7 07	7 03	6 59	6 55	6 52	6 48	6 44	6 40	6 36	6 32	6 28	6 24	6 19	6 15	6 11	6 07	6 02	R.	41
	S.	4 35	4 43	4 51	4 57	5 03	5 08	5 13	5 17	5 22	5 26	5 29	5 33	5 37	5 40	5 44	5 47	5 50	5 53	5 56	5 59	6 01	6 04	6 07	6 10	6 12	S.	
42	R.	7 24	7 28	7 27	7 25	7 22	7 19	7 16	7 12	7 09	7 05	7 01	6 57	6 53	6 49	6 45	6 41	6 37	6 32	6 28	6 24	6 20	6 15	6 11	6 07	6 02	R.	42
	S.	4 32	4 40	4 48	4 55	5 00	5 06	5 11	5 15	5 20	5 24	5 28	5 32	5 35	5 39	5 43	5 46	5 49	5 52	5 55	5 58	6 01	6 04	6 07	6 10	6 12	S.	
43	R.	7 28	7 31	7 30	7 28	7 25	7 21	7 18	7 14	7 11	7 07	7 03	6 59	6 55	6 50	6 46	6 42	6 38	6 33	6 29	6 25	6 20	6 16	6 11	6 07	6 02	R.	43
	S.	4 29	4 37	4 45	4 52	4 58	5 03	5 08	5 13	5 18	5 22	5 26	5 30	5 34	5 37	5 41	5 45	5 48	5 51	5 54	5 58	6 01	6 04	6 07	6 10	6 12	S.	
44	R.	7 31	7 34	7 33	7 31	7 28	7 24	7 21	7 17	7 13	7 09	7 04	7 00	6 56	6 52	6 48	6 43	6 39	6 34	6 30	6 25	6 20	6 16	6 11	6 07	6 02	R.	44
	S.	4 25	4 33	4 42	4 49	4 55	5 00	5 06	5 11	5 16	5 20	5 24	5 28	5 32	5 36	5 40	5 43	5 47	5 50	5 54	5 57	6 00	6 03	6 06	6 10	6 13	S.	
45	R.	7 35	7 38	7 37	7 34	7 31	7 27	7 23	7 19	7 15	7 11	7 06	7 02	6 58	6 53	6 49	6 44	6 40	6 35	6 30	6 26	6 21	6 16	6 11	6 07	6 02	R.	45
	S.	4 22	4 30	4 39	4 46	4 52	4 58	5 03	5 08	5 13	5 18	5 22	5 27	5 31	5 35	5 39	5 42	5 46	5 50	5 53	5 57	6 00	6 03	6 06	6 10	6 13	S.	
46	R.	7 38	7 41	7 40	7 37	7 34	7 30	7 26	7 22	7 17	7 13	7 08	7 04	6 59	6 55	6 50	6 45	6 41	6 36	6 31	6 26	6 21	6 16	6 11	6 07	6 02	R.	46
	S.	4 18	4 26	4 35	4 42	4 49	4 55	5 01	5 06	5 11	5 16	5 20	5 25	5 29	5 33	5 37	5 41	5 45	5 49	5 52	5 56	5 59	6 03	6 06	6 10	6 13	S.	
47	R.	7 42	7 45	7 44	7 41	7 37	7 33	7 29	7 24	7 20	7 15	7 10	7 06	7 01	6 56	6 52	6 47	6 42	6 37	6 32	6 27	6 22	6 17	6 12	6 07	6 02	R.	47
	S.	4 14	4 22	4 32	4 39	4 46	4 52	4 58	5 03	5 09	5 14	5 18	5 23	5 27	5 31	5 36	5 40	5 44	5 48	5 52	5 56	5 59	6 03	6 06	6 10	6 13	S.	
48	R.	7 46	7 49	7 48	7 44	7 40	7 36	7 32	7 27	7 22	7 17	7 12	7 08	7 03	6 58	6 53	6 48	6 43	6 38	6 33	6 28	6 22	6 17	6 12	6 07	6 02	R.	48
	S.	4 10	4 18	4 28	4 35	4 42	4 49	4 55	5 01	5 06	5 11	5 16	5 21	5 26	5 30	5 34	5 39	5 43	5 47	5 51	5 55	5 58	6 02	6 06	6 10	6 13	S.	
49	R.	7 51	7 53	7 52	7 48	7 44	7 39	7 35	7 30	7 25	7 20	7 15	7 10	7 05	6 59	6 54	6 49	6 44	6 39	6 33	6 28	6 23	6 18	6 12	6 07	6 01	R.	49
	S.	4 06	4 14	4 24	4 32	4 39	4 45	4 52	4 58	5 03	5 09	5 14	5 19	5 24	5 28	5 33	5 37	5 41	5 46	5 50	5 54	5 58	6 02	6 06	6 10	6 13	S.	
50	R.	7 55	7 58	7 56	7 52	7 48	7 43	7 38	7 33	7 28	7 22	7 17	7 12	7 07	7 01	6 56	6 51	6 45	6 40	6 34	6 29	6 23	6 18	6 12	6 07	6 01	R.	50
	S.	4 01	4 10	4 20	4 28	4 35	4 42	4 49	4 55	5 01	5 06	5 11	5 17	5 22	5 26	5 31	5 36	5 40	5 45	5 49	5 53	5 57	6 01	6 05	6 10	6 13	S.	
51	R.	8 00	8 02	8 00	7 56	7 51	7 46	7 41	7 36	7 31	7 25	7 20	7 14	7 09	7 03	6 58	6 52	6 47	6 41	6 35	6 30	6 24	6 19	6 13	6 07	6 01	R.	51
	S.	3 56	4 05	4 15	4 24	4 31	4 38	4 45	4 52	4 58	5 03	5 09	5 14	5 20	5 25	5 30	5 34	5 39	5 43	5 48	5 52	5 56	6 01	6 05	6 09	6 13	S.	
52	R.	8 05	8 07	8 05	8 00	7 55	7 50	7 45	7 39	7 34	7 28	7 22	7 16	7 11	7 05	6 59	6 54	6 48	6 42	6 36	6 31	6 25	6 19	6 13	6 07	6 01	R.	52
	S.	3 51	4 00	4 11	4 19	4 27	4 35	4 42	4 48	4 55	5 01	5 06	5 12	5 18	5 23	5 28	5 33	5 38	5 42	5 47	5 52	5 56	6 01	6 05	6 09	6 13	S.	
53	R.	8 11	8 13	8 10	8 05	7 59	7 54	7 48	7 43	7 37	7 31	7 25	7 19	7 13	7 07	7 01	6 55	6 49	6 43	6 37	6 31	6 25	6 19	6 13	6 07	6 01	R.	53
	S.	3 46	3 55	4 06	4 15	4 23	4 31	4 38	4 45	4 52	4 58	5 04	5 10	5 15	5 21	5 26	5 31	5 36	5 41	5 46	5 51	5 55	6 00	6 04	6 09	6 13	S.	
54	R.	8 16	8 18	8 15	8 09	8 04	7 58	7 52	7 46	7 40	7 34	7 28	7 21	7 15	7 09	7 03	6 57	6 51	6 44	6 38	6 32	6 26	6 20	6 13	6 07	6 01	R.	54
	S.	3 40	3 49	4 01	4 10	4 19	4 27	4 34	4 41	4 48	4 55	5 01	5 07	5 13	5 19	5 24	5 30	5 35	5 40	5 45	5 50	5 55	6 00	6 04	6 09	6 14	S.	
55	R.	8 22	8 24	8 20	8 15	8 09	8 02	7 56	7 50	7 44	7 37	7 31	7 24	7 18	7 11	7 05	6 59	6 52	6 46	6 40	6 33	6 27	6 20	6 13	6 07	6 01	R.	55
	S.	3 34	3 44	3 55	4 05	4 14	4 22	4 30	4 38	4 45	4 51	4 58	5 04	5 11	5 16	5 22	5 28	5 33	5 39	5 44	5 49	5 54	5 59	6 04	6 09	6 14	S.	
56	R.	8 29	8 30	8 26	8 20	8 14	8 07	8 01	7 54	7 47	7 41	7 34	7 27	7 21	7 14	7 07	7 01	6 54	6 47	6 41	6 34	6 27	6 21	6 14	6 07	6 01	R.	56
	S.	3 27	3 37	3 49	3 59	4 08	4 17	4 26	4 34	4 41	4 48	4 55	5 01	5 08	5 14	5 20	5 26	5 32	5 37	5 43	5 48	5 53	5 59	6 04	6 09	6 14	S.	
57	R.	8 36	8 37	8 32	8 26	8 19	8 12	8 05	7 58	7 51	7 44	7 37	7 30	7 23	7 16	7 10	7 03	6 56	6 49	6 42	6 35	6 28	6 21	6 14	6 07	6 00	R.	57
	S.	3 20	3 30	3 43	3 54	4 03	4 12	4 21	4 29	4 37	4 44	4 51	4 58	5 05	5 11	5 18	5 24	5 30	5 36	5 41	5 47	5 52	5 58	6 03	6 09	6 14	S.	
58	R.	8 44	8 44	8 39	8 32	8 25	8 17	8 10	8 03	7 55	7 48	7 41	7 33	7 26	7 19	7 12	7 05	6 57	6 50	6 43	6 36	6 29	6 22	6 14	6 07	6 00	R.	58
	S.	3 13	3 23	3 36	3 47	3 57	4 07	4 16	4 25	4 33	4 41	4 48	4 55	5 02	5 09	5 16	5 22	5 28	5 34	5 40	5 46	5 52	5 58	6 03	6 09	6 14	S.	
59	R.	8 52	8 52	8 46	8 39	8 31	8 23	8 15	8 08	8 00	7 52	7 44	7 37	7 29	7 21	7 14	7 07	6 59	6 52	6 45	6 37	6 30	6 22	6 15	6 07	6 00	R.	59
	S.	3 05	3 15	3 29	3 41	3 52	4 02	4 11	4 20	4 29	4 37	4 44	4 52	4 59	5 06	5 13	5 20	5 26	5 33	5 39	5 45	5 51	5 57	6 03	6 09	6 15	S.	
60	R.	9 01	9 01	8 54	8 46	8 38	8 29	8 21	8 13	8 05	7 56	7 48	7 40	7 32	7 24	7 17	7 09	7 01	6 54	6 46	6 39	6 31	6 23	6 15	6 08	6 00	R.	60
	S.	2 56	3 06	3 21	3 34	3 45	3 55	4 05	4 15	4 24	4 32	4 40	4 48	4 56	5 03	5 10	5 17	5 24	5 31	5 37	5 44	5 50	5 56	6 02	6 09	6 15	S.	

TABLE 10.

Mean Time of Sun's Visible Rising and Setting.

South latitude: 0° to 20°—March 21 to June 22.

[R=Local mean time of sun's visible rising. S=Local mean time of sun's visible setting.]

Lat. S.	Approx. date.	MARCH.					APRIL.										MAY.							JUNE.			Approx. date.	Lat. S.
		21	23	26	28	31	3	5	8	11	13	16	19	22	25	28	1	5	8	12	16	21	26	1	10	22		
	Dec. N.	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	13°	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	23° 27′	Dec. N.	
°		h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.		°
0	R.	6 04	6 03	6 02	6 01	6 00	6 00	5 59	5 58	5 57	5 57	5 56	5 55	5 55	5 54	5 54	5 53	5 53	5 52	5 52	5 52	5 52	5 53	5 54	5 55	5 57	R.	0
	S.	6 11	6 11	6 10	6 09	6 08	6 08	6 07	6 06	6 05	6 05	6 04	6 03	6 03	6 02	6 02	6 01	6 01	6 00	6 00	6 00	6 00	6 01	6 02	6 03	6 05	S.	
1	R.	6 04	6 03	6 02	6 02	6 01	6 00	5 59	5 58	5 58	5 58	5 57	5 56	5 56	5 55	5 55	5 54	5 54	5 54	5 54	5 54	5 54	5 54	5 55	5 57	5 59	R.	1
	S.	6 11	6 10	6 09	6 09	6 08	6 07	6 06	6 05	6 04	6 04	6 03	6 02	6 02	6 01	6 01	6 00	5 59	5 59	5 59	5 59	5 59	5 59	6 00	6 02	6 04	S.	
2	R.	6 04	6 03	6 02	6 02	6 01	6 00	6 00	5 59	5 59	5 58	5 57	5 57	5 56	5 56	5 56	5 55	5 55	5 55	5 55	5 55	5 55	5 56	5 57	5 58	6 01	R.	2
	S.	6 11	6 10	6 09	6 09	6 08	6 07	6 06	6 05	6 04	6 03	6 02	6 02	6 01	6 00	6 00	5 59	5 58	5 58	5 58	5 58	5 57	5 58	5 59	6 00	6 03	S.	
3	R.	6 04	6 03	6 02	6 02	6 01	6 01	6 00	5 59	5 59	5 59	5 58	5 57	5 57	5 57	5 57	5 56	5 56	5 56	5 56	5 56	5 57	5 57	5 58	6 00	6 03	R.	3
	S.	6 11	6 10	6 09	6 08	6 07	6 06	6 05	6 04	6 03	6 03	6 02	6 01	6 00	6 00	5 59	5 58	5 57	5 57	5 56	5 56	5 56	5 56	5 57	5 59	6 01	S.	
4	R.	6 04	6 03	6 02	6 02	6 01	6 01	6 00	6 00	6 00	5 59	5 58	5 58	5 58	5 58	5 58	5 57	5 57	5 57	5 57	5 58	5 58	5 59	6 00	6 01	6 04	R.	4
	S.	6 11	6 10	6 09	6 08	6 07	6 06	6 05	6 04	6 03	6 02	6 01	6 00	5 59	5 59	5 58	5 57	5 56	5 56	5 55	5 55	5 55	5 55	5 56	5 57	5 59	S.	
5	R.	6 04	6 03	6 02	6 02	6 02	6 01	6 01	6 00	6 00	6 00	5 59	5 59	5 59	5 59	5 59	5 58	5 58	5 58	5 59	5 59	5 59	6 00	6 02	6 03	6 06	R.	5
	S.	6 11	6 10	6 09	6 08	6 07	6 06	6 05	6 03	6 02	6 01	6 00	5 59	5 58	5 58	5 57	5 56	5 55	5 54	5 54	5 53	5 53	5 53	5 54	5 55	5 57	S.	
6	R.	6 03	6 03	6 02	6 02	6 02	6 02	6 01	6 01	6 01	6 01	6 00	6 00	6 00	6 00	6 00	6 00	6 00	6 00	6 00	6 00	6 01	6 02	6 03	6 05	6 08	R.	6
	S.	6 11	6 10	6 09	6 08	6 07	6 06	6 04	6 03	6 02	6 01	6 00	5 59	5 58	5 57	5 56	5 55	5 54	5 53	5 53	5 52	5 52	5 52	5 52	5 54	5 56	S.	
7	R.	6 03	6 03	6 03	6 03	6 02	6 02	6 02	6 01	6 01	6 01	6 01	6 01	6 01	6 01	6 01	6 01	6 01	6 01	6 01	6 02	6 02	6 03	6 05	6 07	6 10	R.	7
	S.	6 11	6 10	6 09	6 08	6 06	6 05	6 04	6 02	6 01	6 00	5 59	5 58	5 57	5 56	5 55	5 54	5 53	5 52	5 51	5 51	5 50	5 50	5 51	5 52	5 54	S.	
8	R.	6 03	6 03	6 03	6 03	6 02	6 02	6 02	6 02	6 02	6 02	6 01	6 01	6 02	6 02	6 02	6 02	6 02	6 02	6 02	6 03	6 04	6 05	6 06	6 08	6 11	R.	8
	S.	6 11	6 10	6 09	6 08	6 06	6 05	6 04	6 02	6 01	6 00	5 58	5 57	5 56	5 55	5 54	5 53	5 52	5 51	5 50	5 50	5 49	5 49	5 49	5 50	5 52	S.	
9	R.	6 03	6 03	6 03	6 03	6 03	6 03	6 02	6 02	6 02	6 02	6 02	6 02	6 03	6 03	6 03	6 03	6 03	6 03	6 04	6 04	6 05	6 06	6 08	6 10	6 13	R.	9
	S.	6 11	6 10	6 09	6 08	6 06	6 05	6 03	6 01	6 00	5 59	5 57	5 56	5 55	5 54	5 53	5 52	5 50	5 49	5 49	5 48	5 47	5 47	5 47	5 48	5 50	S.	
10	R.	6 03	6 03	6 03	6 03	6 03	6 03	6 03	6 03	6 03	6 03	6 03	6 03	6 03	6 03	6 04	6 04	6 04	6 04	6 05	6 06	6 07	6 08	6 10	6 12	6 15	R.	10
	S.	6 11	6 10	6 09	6 08	6 06	6 05	6 03	6 01	5 59	5 58	5 57	5 56	5 54	5 53	5 52	5 51	5 49	5 48	5 48	5 47	5 46	5 46	5 46	5 47	5 49	S.	
11	R.	6 03	6 03	6 03	6 03	6 03	6 03	6 03	6 03	6 04	6 04	6 04	6 04	6 04	6 04	6 05	6 05	6 05	6 05	6 06	6 07	6 08	6 09	6 11	6 14	6 17	R.	11
	S.	6 11	6 10	6 08	6 07	6 05	6 04	6 02	6 00	5 59	5 58	5 56	5 55	5 53	5 52	5 51	5 50	5 48	5 47	5 46	5 45	5 44	5 44	5 44	5 45	5 47	S.	
12	R.	6 03	6 03	6 03	6 04	6 04	6 04	6 04	6 04	6 04	6 04	6 04	6 05	6 05	6 05	6 06	6 06	6 06	6 07	6 08	6 09	6 10	6 11	6 13	6 15	6 18	R.	12
	S.	6 11	6 10	6 08	6 07	6 05	6 04	6 02	6 00	5 58	5 57	5 55	5 54	5 52	5 51	5 50	5 49	5 47	5 46	5 45	5 44	5 43	5 43	5 43	5 43	5 45	S.	
13	R.	6 03	6 04	6 04	6 04	6 04	6 04	6 04	6 04	6 05	6 05	6 05	6 06	6 06	6 06	6 07	6 07	6 08	6 08	6 09	6 10	6 11	6 13	6 15	6 17	6 20	R.	13
	S.	6 11	6 10	6 08	6 06	6 04	6 03	6 01	5 59	5 58	5 56	5 54	5 53	5 51	5 50	5 49	5 47	5 46	5 44	5 43	5 42	5 41	5 41	5 41	5 41	5 43	S.	
14	R.	6 03	6 04	6 04	6 04	6 04	6 05	6 05	6 05	6 05	6 06	6 06	6 06	6 07	6 07	6 08	6 08	6 09	6 10	6 11	6 12	6 13	6 14	6 16	6 19	6 22	R.	14
	S.	6 11	6 10	6 08	6 06	6 04	6 03	6 01	5 59	5 57	5 56	5 54	5 52	5 51	5 49	5 48	5 46	5 45	5 43	5 42	5 41	5 40	5 39	5 39	5 40	5 42	S.	
15	R.	6 03	6 04	6 04	6 05	6 05	6 05	6 05	6 05	6 06	6 06	6 06	6 07	6 08	6 08	6 09	6 09	6 10	6 11	6 12	6 13	6 14	6 16	6 18	6 21	6 24	R.	15
	S.	6 11	6 10	6 08	6 06	6 04	6 02	6 00	5 58	5 57	5 55	5 53	5 52	5 50	5 48	5 47	5 46	5 43	5 42	5 41	5 39	5 38	5 38	5 37	5 38	5 40	S.	
16	R.	6 03	6 04	6 04	6 05	6 05	6 05	6 06	6 06	6 06	6 07	6 07	6 08	6 09	6 09	6 10	6 10	6 11	6 12	6 13	6 15	6 16	6 18	6 20	6 23	6 26	R.	16
	S.	6 11	6 10	6 08	6 06	6 04	6 02	6 00	5 58	5 56	5 54	5 52	5 51	5 49	5 47	5 46	5 44	5 42	5 40	5 39	5 38	5 37	5 36	5 36	5 36	5 38	S.	
17	R.	6 03	6 04	6 04	6 05	6 05	6 06	6 06	6 06	6 07	6 08	6 08	6 09	6 10	6 10	6 11	6 12	6 13	6 14	6 15	6 16	6 18	6 20	6 22	6 25	6 28	R.	17
	S.	6 11	6 10	6 08	6 06	6 04	6 02	6 00	5 58	5 56	5 54	5 52	5 50	5 48	5 46	5 44	5 43	5 41	5 39	5 38	5 36	5 35	5 34	5 34	5 34	5 36	S.	
18	R.	6 03	6 04	6 04	6 05	6 05	6 06	6 06	6 07	6 08	6 08	6 09	6 10	6 11	6 11	6 12	6 13	6 14	6 15	6 16	6 18	6 19	6 21	6 23	6 26	6 30	R.	18
	S.	6 11	6 09	6 07	6 05	6 03	6 01	5 59	5 57	5 55	5 53	5 51	5 49	5 47	5 45	5 43	5 42	5 40	5 38	5 36	5 35	5 33	5 33	5 32	5 32	5 34	S.	
19	R.	6 03	6 04	6 04	6 05	6 06	6 06	6 07	6 07	6 08	6 09	6 10	6 11	6 12	6 12	6 13	6 14	6 15	6 16	6 18	6 19	6 21	6 23	6 25	6 28	6 32	R.	19
	S.	6 11	6 09	6 07	6 05	6 03	6 01	5 59	5 56	5 54	5 52	5 50	5 48	5 46	5 44	5 42	5 40	5 38	5 36	5 35	5 33	5 32	5 31	5 30	5 30	5 32	S.	
20	R.	6 03	6 04	6 04	6 05	6 06	6 07	6 07	6 08	6 09	6 10	6 10	6 11	6 12	6 13	6 14	6 15	6 16	6 17	6 19	6 21	6 22	6 24	6 27	6 30	6 34	R.	20
	S.	6 11	6 09	6 07	6 05	6 03	6 01	5 58	5 56	5 54	5 52	5 49	5 47	5 45	5 43	5 41	5 39	5 37	5 35	5 33	5 32	5 30	5 29	5 28	5 28	5 30	S.	

TABLE 10.

Mean Time of Sun's Visible Rising and Setting.

South latitude: 21° to 40°—March 21 to June 22.

[R=Local mean time of sun's visible rising. S=Local mean time of sun's visible setting.]

Lat. S.	Approx. date	MARCH.					APRIL.										MAY.							JUNE.			Approx. date	Lat. S.
		21	23	26	28	31	3	5	8	11	13	16	19	22	25	28	1	5	8	12	16	21	26	1	10	22		
	Dec. N.	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	13°	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	23° 27′	Dec. N.	
°		h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.		°
21	R.	6 03	6 04	6 05	6 06	6 06	6 07	6 08	6 09	6 10	6 11	6 11	6 12	6 13	6 14	6 15	6 16	6 18	6 19	6 21	6 22	6 24	6 26	6 29	6 32	6 36	R.	21
	S.	6 11	6 09	6 07	6 05	6 02	6 00	5 58	5 55	5 53	5 51	5 48	5 46	5 44	5 42	5 40	5 38	5 36	5 34	5 32	5 30	5 28	5 27	5 26	5 26	5 28	S.	
22	R.	6 03	6 04	6 05	6 06	6 06	6 07	6 08	6 09	6 10	6 11	6 12	6 13	6 14	6 15	6 16	6 17	6 19	6 20	6 22	6 24	6 26	6 28	6 31	6 34	6 38	R.	22
	S.	6 11	6 09	6 07	6 05	6 02	6 00	5 57	5 55	5 52	5 50	5 48	5 46	5 43	5 41	5 39	5 37	5 35	5 33	5 31	5 29	5 27	5 26	5 25	5 24	5 26	S.	
23	R.	6 03	6 04	6 05	6 06	6 07	6 08	6 09	6 10	6 11	6 12	6 13	6 14	6 15	6 16	6 17	6 19	6 20	6 22	6 24	6 25	6 27	6 30	6 33	6 36	6 40	R.	23
	S.	6 11	6 09	6 07	6 05	6 02	6 00	5 57	5 54	5 52	5 50	5 47	5 45	5 42	5 40	5 37	5 35	5 33	5 31	5 29	5 27	5 25	5 24	5 23	5 22	5 24	S.	
24	R.	6 03	6 04	6 05	6 06	6 07	6 08	6 09	6 10	6 11	6 12	6 13	6 15	6 16	6 17	6 18	6 20	6 22	6 23	6 25	6 27	6 29	6 31	6 34	6 38	6 42	R.	24
	S.	6 11	6 09	6 07	6 04	6 01	5 59	5 56	5 54	5 51	5 49	5 46	5 44	5 41	5 39	5 36	5 34	5 32	5 30	5 28	5 26	5 24	5 22	5 21	5 20	5 22	S.	
25	R.	6 03	6 04	6 05	6 07	6 08	6 09	6 10	6 11	6 12	6 13	6 14	6 16	6 17	6 19	6 20	6 22	6 23	6 25	6 27	6 29	6 31	6 33	6 36	6 40	6 44	R.	25
	S.	6 11	6 09	6 06	6 04	6 01	5 59	5 56	5 53	5 50	5 48	5 45	5 43	5 40	5 38	5 35	5 33	5 30	5 28	5 26	5 24	5 22	5 20	5 19	5 18	5 20	S.	
26	R.	6 03	6 04	6 05	6 07	6 08	6 09	6 10	6 11	6 13	6 14	6 15	6 16	6 18	6 20	6 21	6 23	6 24	6 26	6 28	6 30	6 32	6 35	6 39	6 42	6 46	R.	26
	S.	6 11	6 09	6 06	6 04	6 01	5 58	5 55	5 52	5 50	5 48	5 45	5 42	5 39	5 37	5 34	5 32	5 29	5 27	5 24	5 22	5 20	5 18	5 17	5 16	5 18	S.	
27	R.	6 03	6 04	6 05	6 07	6 08	6 10	6 11	6 12	6 13	6 15	6 16	6 17	6 19	6 21	6 22	6 24	6 26	6 28	6 30	6 32	6 34	6 37	6 41	6 45	6 48	R.	27
	S.	6 11	6 09	6 06	6 03	6 00	5 58	5 55	5 52	5 49	5 47	5 44	5 41	5 38	5 36	5 33	5 31	5 28	5 25	5 23	5 21	5 18	5 16	5 15	5 14	5 15	S.	
28	R.	6 03	6 04	6 06	6 07	6 08	6 10	6 11	6 12	6 14	6 16	6 17	6 18	6 20	6 22	6 23	6 25	6 27	6 29	6 31	6 34	6 36	6 39	6 43	6 47	6 50	R.	28
	S.	6 11	6 09	6 06	6 03	6 00	5 57	5 54	5 51	5 49	5 46	5 43	5 40	5 37	5 35	5 32	5 29	5 26	5 24	5 21	5 19	5 16	5 14	5 13	5 12	5 13	S.	
29	R.	6 03	6 04	6 06	6 07	6 09	6 10	6 12	6 13	6 15	6 16	6 18	6 19	6 21	6 23	6 24	6 27	6 29	6 31	6 33	6 36	6 38	6 41	6 45	6 49	6 53	R.	29
	S.	6 11	6 09	6 06	6 03	6 00	5 57	5 54	5 51	5 48	5 45	5 42	5 39	5 36	5 33	5 30	5 28	5 25	5 22	5 19	5 17	5 14	5 12	5 11	5 10	5 11	S.	
30	R.	6 03	6 04	6 06	6 07	6 09	6 11	6 12	6 13	6 15	6 17	6 18	6 20	6 22	6 24	6 26	6 28	6 30	6 32	6 35	6 37	6 40	6 43	6 47	6 51	6 55	R.	30
	S.	6 12	6 09	6 06	6 03	6 00	5 57	5 53	5 50	5 47	5 44	5 41	5 38	5 35	5 32	5 29	5 26	5 23	5 20	5 18	5 15	5 12	5 10	5 09	5 08	5 09	S.	
31	R.	6 03	6 04	6 06	6 08	6 09	6 11	6 13	6 14	6 16	6 18	6 19	6 21	6 23	6 25	6 28	6 30	6 32	6 34	6 36	6 39	6 42	6 45	6 49	6 53	6 57	R.	31
	S.	6 12	6 09	6 06	6 03	5 59	5 56	5 53	5 49	5 46	5 43	5 40	5 37	5 34	5 31	5 28	5 25	5 22	5 19	5 16	5 13	5 10	5 08	5 06	5 05	5 06	S.	
32	R.	6 03	6 05	6 06	6 08	6 10	6 12	6 13	6 15	6 17	6 19	6 20	6 22	6 24	6 26	6 29	6 31	6 33	6 35	6 38	6 41	6 44	6 47	6 51	6 56	7 00	R.	32
	S.	6 12	6 09	6 06	6 03	5 59	5 56	5 52	5 49	5 46	5 43	5 39	5 36	5 33	5 30	5 27	5 24	5 20	5 17	5 14	5 11	5 08	5 06	5 04	5 03	5 04	S.	
33	R.	6 03	6 05	6 06	6 08	6 10	6 12	6 14	6 15	6 17	6 19	6 21	6 23	6 26	6 28	6 30	6 32	6 35	6 37	6 40	6 43	6 46	6 50	6 54	6 58	7 02	R.	33
	S.	6 12	6 09	6 05	6 02	5 58	5 55	5 52	5 48	5 45	5 42	5 38	5 35	5 32	5 29	5 26	5 22	5 19	5 15	5 12	5 09	5 06	5 04	5 02	5 00	5 01	S.	
34	R.	6 03	6 05	6 07	6 09	6 11	6 13	6 14	6 16	6 18	6 20	6 22	6 24	6 27	6 29	6 32	6 34	6 36	6 39	6 42	6 45	6 48	6 52	6 56	7 01	7 05	R.	34
	S.	6 12	6 09	6 05	6 02	5 58	5 55	5 51	5 48	5 44	5 41	5 37	5 34	5 31	5 27	5 24	5 21	5 17	5 14	5 11	5 07	5 04	5 02	5 00	4 58	4 59	S.	
35	R.	6 03	6 05	6 07	6 09	6 11	6 13	6 15	6 17	6 19	6 21	6 23	6 26	6 28	6 31	6 33	6 36	6 38	6 41	6 44	6 47	6 50	6 54	6 58	7 03	7 07	R.	35
	S.	6 12	6 09	6 05	6 02	5 58	5 54	5 51	5 47	5 43	5 40	5 36	5 33	5 29	5 26	5 22	5 19	5 15	5 12	5 09	5 06	5 02	5 00	4 57	4 55	4 56	S.	
36	R.	6 03	6 05	6 07	6 09	6 11	6 14	6 16	6 18	6 20	6 22	6 24	6 27	6 29	6 32	6 35	6 37	6 40	6 43	6 46	6 49	6 52	6 56	7 01	7 06	7 10	R.	36
	S.	6 12	6 09	6 05	6 01	5 57	5 54	5 50	5 46	5 43	5 39	5 35	5 32	5 28	5 25	5 21	5 17	5 14	5 10	5 07	5 04	5 00	4 57	4 55	4 53	4 54	S.	
37	R.	6 03	6 05	6 07	6 10	6 12	6 14	6 16	6 18	6 21	6 23	6 25	6 28	6 31	6 33	6 36	6 39	6 42	6 45	6 48	6 51	6 55	6 59	7 03	7 08	7 13	R.	37
	S.	6 12	6 08	6 04	6 01	5 57	5 53	5 49	5 45	5 42	5 38	5 34	5 31	5 27	5 23	5 19	5 16	5 12	5 08	5 05	5 01	4 58	4 55	4 52	4 50	4 51	S.	
38	R.	6 02	6 05	6 07	6 10	6 12	6 15	6 17	6 19	6 21	6 24	6 26	6 29	6 32	6 35	6 38	6 40	6 43	6 46	6 50	6 53	6 57	7 01	7 06	7 11	7 16	R.	38
	S.	6 12	6 08	6 04	6 01	5 57	5 53	5 49	5 45	5 41	5 37	5 33	5 30	5 26	5 22	5 18	5 14	5 10	5 06	5 03	4 59	4 55	4 52	4 50	4 47	4 48	S.	
39	R.	6 02	6 05	6 07	6 10	6 12	6 15	6 17	6 20	6 22	6 25	6 27	6 30	6 33	6 36	6 39	6 42	6 45	6 48	6 52	6 56	7 00	7 04	7 09	7 14	7 19	R.	39
	S.	6 12	6 08	6 04	6 00	5 56	5 52	5 48	5 44	5 40	5 36	5 32	5 28	5 24	5 20	5 16	5 12	5 08	5 04	5 00	4 57	4 53	4 50	4 47	4 44	4 45	S.	
40	R.	6 02	6 05	6 07	6 10	6 13	6 16	6 18	6 21	6 23	6 26	6 28	6 31	6 35	6 38	6 41	6 44	6 47	6 50	6 54	6 58	7 02	7 06	7 11	7 17	7 22	R.	40
	S.	6 12	6 08	6 04	6 00	5 56	5 52	5 47	5 43	5 39	5 35	5 31	5 27	5 23	5 19	5 15	5 11	5 06	5 02	4 58	4 54	4 50	4 47	4 44	4 41	4 42	S.	

TABLE 10.

Mean Time of Sun's Visible Rising and Setting.

South Latitude: 41° to 60°—March 21 to June 22.

[R=Local mean time of sun's visible rising. S=Local mean time of sun's visible setting.]

Lat. S.	Approx. date.	MARCH.					APRIL.										MAY.							JUNE.			Approx. date.	Lat. S.
		21	23	26	28	31	3	5	8	11	13	16	19	22	25	28	1	5	8	12	16	21	26	1	10	22		
	Dec. N.	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	13°	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	23° 27′	Dec. N.	
°		h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.		°
41	R.	6 02	6 05	6 08	6 11	6 13	6 16	6 19	6 21	6 24	6 27	6 30	6 33	6 36	6 39	6 43	6 46	6 49	6 53	6 57	7 01	7 05	7 09	7 14	7 20	7 25	R.	41
	S.	6 12	6 08	6 04	6 00	5 55	5 51	5 47	5 42	5 38	5 34	5 30	5 26	5 21	5 17	5 13	5 09	5 04	5 00	4 56	4 52	4 48	4 44	4 41	4 38	4 39	S.	
42	R.	6 02	6 05	6 08	6 11	6 14	6 17	6 19	6 22	6 25	6 28	6 31	6 34	6 38	6 41	6 44	6 48	6 51	6 55	6 59	7 03	7 07	7 12	7 17	7 23	7 28	R.	42
	S.	6 12	6 08	6 04	6 00	5 55	5 51	5 46	5 42	5 37	5 33	5 29	5 24	5 20	5 16	5 11	5 07	5 02	4 58	4 54	4 50	4 46	4 42	4 38	4 35	4 36	S.	
43	R.	6 02	6 05	6 08	6 11	6 14	6 17	6 20	6 23	6 26	6 29	6 32	6 36	6 39	6 43	6 46	6 50	6 53	6 57	7 01	7 05	7 10	7 15	7 20	7 26	7 31	R.	43
	S.	6 12	6 08	6 03	5 59	5 54	5 50	5 45	5 41	5 36	5 32	5 27	5 23	5 18	5 14	5 09	5 05	5 00	4 56	4 51	4 47	4 43	4 39	4 35	4 32	4 32	S.	
44	R.	6 02	6 05	6 08	6 11	6 14	6 18	6 21	6 24	6 27	6 31	6 34	6 37	6 41	6 44	6 48	6 52	6 56	6 59	7 04	7 08	7 13	7 18	7 23	7 30	7 35	R.	44
	S.	6 13	6 08	6 03	5 59	5 54	5 50	5 45	5 40	5 35	5 31	5 26	5 21	5 17	5 12	5 08	5 03	4 58	4 53	4 49	4 44	4 40	4 36	4 32	4 29	4 29	S.	
45	R.	6 02	6 03	6 08	6 12	6 15	6 18	6 21	6 24	6 28	6 32	6 35	6 39	6 42	6 46	6 50	6 54	6 58	7 02	7 06	7 11	7 16	7 21	7 27	7 33	7 38	R.	45
	S.	6 13	6 08	6 03	5 59	5 54	5 49	5 44	5 39	5 34	5 30	5 25	5 20	5 15	5 11	5 06	5 01	4 56	4 51	4 46	4 42	4 37	4 33	4 29	4 25	4 25	S.	
46	R.	6 02	6 05	6 08	6 12	6 15	6 19	6 22	6 25	6 29	6 33	6 36	6 40	6 44	6 48	6 52	6 56	7 00	7 04	7 09	7 14	7 19	7 24	7 30	7 37	7 42	R.	46
	S.	6 13	6 08	6 03	5 58	5 53	5 48	5 43	5 38	5 33	5 28	5 23	5 18	5 14	5 09	5 04	4 59	4 54	4 49	4 44	4 39	4 34	4 29	4 25	4 22	4 22	S.	
47	R.	6 02	6 05	6 09	6 12	6 16	6 19	6 23	6 26	6 30	6 34	6 38	6 42	6 46	6 50	6 54	6 58	7 02	7 07	7 12	7 17	7 22	7 28	7 34	7 41	7 46	R.	47
	S.	6 13	6 08	6 03	5 58	5 53	5 48	5 43	5 37	5 32	5 27	5 22	5 17	5 12	5 07	5 02	4 57	4 51	4 46	4 41	4 36	4 31	4 26	4 22	4 18	4 18	S.	
48	R.	6 02	6 05	6 09	6 13	6 16	6 20	6 24	6 27	6 31	6 35	6 39	6 43	6 47	6 52	6 56	7 00	7 05	7 10	7 15	7 20	7 25	7 31	7 38	7 45	7 50	R.	48
	S.	6 13	6 08	6 03	5 58	5 52	5 47	5 42	5 36	5 31	5 26	5 20	5 15	5 10	5 05	5 00	4 54	4 49	4 43	4 38	4 33	4 27	4 22	4 18	4 14	4 14	S.	
49	R.	6 01	6 05	6 09	6 13	6 17	6 21	6 24	6 28	6 33	6 37	6 41	6 45	6 49	6 54	6 58	7 03	7 08	7 13	7 18	7 23	7 29	7 35	7 42	7 49	7 54	R.	49
	S.	6 13	6 08	6 03	5 57	5 52	5 47	5 41	5 35	5 30	5 25	5 19	5 14	5 08	5 03	4 57	4 52	4 46	4 40	4 35	4 29	4 24	4 19	4 14	4 10	4 09	S.	
50	R.	6 01	6 05	6 09	6 13	6 17	6 21	6 25	6 29	6 34	6 38	6 42	6 47	6 51	6 56	7 01	7 05	7 10	7 15	7 21	7 27	7 33	7 39	7 46	7 53	7 59	R.	50
	S.	6 13	6 08	6 02	5 56	5 51	5 46	5 40	5 34	5 29	5 23	5 17	5 12	5 06	5 01	4 55	4 49	4 43	4 37	4 32	4 26	4 20	4 15	4 10	4 05	4 05	S.	
51	R.	6 01	6 06	6 10	6 14	6 18	6 22	6 26	6 31	6 35	6 40	6 44	6 48	6 53	6 58	7 03	7 08	7 13	7 18	7 24	7 30	7 36	7 43	7 50	7 58	8 04	R.	51
	S.	6 13	6 08	6 02	5 56	5 50	5 45	5 39	5 33	5 27	5 22	5 16	5 10	5 04	4 58	4 52	4 46	4 40	4 34	4 28	4 22	4 16	4 11	4 05	4 01	4 00	S,	
52	R.	6 01	6 06	6 10	6 14	6 19	6 23	6 27	6 32	6 36	6 41	6 45	6 50	6 55	7 00	7 06	7 11	7 16	7 22	7 28	7 34	7 40	7 47	7 55	8 03	8 09	R.	52
	S.	6 13	6 08	6 02	5 56	5 50	5 44	5 38	5 32	5 26	5 20	5 14	5 08	5 02	4 56	4 50	4 44	4 37	4 31	4 25	4 19	4 12	4 06	4 01	3 56	3 55	S.	
53	R.	6 01	6 06	6 10	6 15	6 19	6 24	6 28	6 33	6 38	6 43	6 47	6 52	6 58	7 03	7 08	7 14	7 19	7 25	7 31	7 38	7 45	7 52	8 00	8 08	8 14	R.	53
	S.	6 13	6 08	6 02	5 56	5 49	5 43	5 37	5 31	5 25	5 19	5 12	5 06	5 00	4 54	4 47	4 41	4 34	4 27	4 21	4 15	4 08	4 02	3 56	3 50	3 49	S.	
54	R.	6 01	6 06	6 10	6 15	6 20	6 25	6 29	6 34	6 39	6 44	6 49	6 54	7 00	7 05	7 11	7 17	7 23	7 29	7 35	7 42	7 49	7 57	8 05	8 14	8 20	R.	54
	S.	6 14	6 08	6 01	5 55	5 49	5 43	5 36	5 30	5 23	5 17	5 10	5 04	4 58	4 51	4 44	4 38	4 31	4 24	4 17	4 11	4 04	3 57	3 51	3 45	3 44.	S.	
55	R.	6 01	6 06	6 11	6 16	6 21	6 26	6 31	6 36	6 41	6 46	6 51	6 57	7 02	7 08	7 14	7 20	7 26	7 32	7 39	7 46	7 54	8 02	8 10	8 19	8 26	R.	55
	S.	6 14	6 08	6 01	5 55	5 48	5 42	5 35	5 28	5 22	5 15	5 08	5 02	4 55	4 48	4 41	4 34	4 27	4 20	4 13	4 06	3 59	3 52	3 45	3 39	3 38	S.	
56	R.	6 01	6 06	6 11	6 16	6 21	6 27	6 32	6 37	6 42	6 48	6 53	6 59	7 05	7 11	7 17	7 24	7 30	7 37	7 44	7 51	7 59	8 07	8 16	8 26	8 33	R.	56
	S.	6 14	6 08	6 01	5 54	5 47	5 41	5 34	5 27	5 20	5 13	5 06	4 59	4 52	4 45	4 38	4 31	4 24	4 16	4 09	4 01	3 54	3 46	3 39	3 33	3 31	S.	
57	R.	6 00	6 06	6 11	6 17	6 22	6 28	6 33	6 38	6 44	6 50	6 56	7 02	7 08	7 14	7 21	7 27	7 34	7 41	7 48	7 56	8 04	8 13	8 22	8 33	8 40	R.	57
	S.	6 14	6 08	6 01	5 54	5 47	5 40	5 32	5 25	5 18	5 11	5 04	4 57	4 50	4 42	4 35	4 27	4 20	4 12	4 04	3 56	3 48	3 41	3 33	3 26	3 24	S.	
58	R.	6 00	6 06	6 11	6 17	6 23	6 29	6 34	6 40	6 46	6 52	6 58	7 04	7 11	7 17	7 24	7 31	7 38	7 45	7 53	8 01	8 10	8 19	8 29	8 40	8 47	R.	58
	S.	6 14	6 07	6 00	5 53	5 46	5 39	5 31	5 24	5 17	5 09	5 02	4 54	4 47	4 39	4 31	4 23	4 15	4 07	3 59	3 51	3 43	3 34	3 26	3 19	3 16	S.	
59	R.	6 00	6 06	6 12	6 18	6 24	6 30	6 36	6 42	6 48	6 54	7 00	7 07	7 14	7 21	7 28	7 35	7 42	7 50	7 58	8 07	8 16	8 26	8 37	8 48	8 55	R.	59
	S.	6 15	6 07	6 00	5 53	5 45	5 38	5 30	5 22	5 15	5 07	4 59	4 52	4 44	4 36	4 28	4 20	4 11	4 02	3 54	3 46	3 37	3 28	3 19	3 11	3 08	S.	
60	R.	6 00	6 06	6 12	6 19	6 25	6 31	6 37	6 43	6 50	6 57	7 03	7 10	7 17	7 24	7 32	7 39	7 47	7 55	8 04	8 13	8 23	8 33	8 45	8 57	9 04	R.	60
	S.	6 15	6 07	5 59	5 52	5 44	5 36	5 28	5 20	5 13	5 05	4 57	4 49	4 41	4 32	4 24	4 15	4 06	3 57	3 48	3 39	3 30	3 21	3 11	3 02	2 59	S.	

TABLE 10.

Mean Time of Sun's Visible Rising and Setting.

South Latitude: 0° to 20°.—June 22 to September 23.

[R=Local mean time of sun's visible rising. S=Local mean time of sun's visible setting.]

Lat. S.	Approx. date.	JUNE.	JULY.					AUGUST.										SEPTEMBER.									Approx. date.	Lat. S.
		22	3	13	19	24	28	2	5	9	12	16	19	22	25	28	30	2	5	8	10	13	16	18	21	23		
	Dec. N.	23° 27′	23°	22°	21°	20°	19°	18°	17°	16°	15°	14°	13°	12°	11°	10°	9°	8°	7°	6°	5°	4°	3°	2°	1°	0°	Dec. N.	
°		h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.		°
0	R.	5 57	6 00	6 01	6 02	6 02	6 02	6 02	6 02	6 01	6 01	6 00	6 00	5 59	5 58	5 57	5 57	5 56	5 55	5 54	5 53	5 52	5 51	5 50	5 49	5 49	R.	0
	S.	6 05	6 08	6 09	6 10	6 10	6 10	6 10	6 10	6 09	6 09	6 08	6 08	6 07	6 06	6 05	6 05	6 04	6 03	6 02	6 01	6 00	5 59	5 58	5 57	5 56	S.	
1	R.	5 59	6 01	6 02	6 03	6 04	6 04	6 04	6 03	6 03	6 02	6 01	6 01	6 00	5 59	5 58	5 57	5 56	5 55	5 54	5 54	5 53	5 52	5 51	5 50	5 49	R.	1
	S.	6 04	6 06	6 07	6 08	6 09	6 09	6 09	6 08	6 08	6 08	6 07	6 07	6 06	6 05	6 04	6 04	6 03	6 02	6 01	6 01	6 00	5 59	5 58	5 57	5 56	S.	
2	R.	6 01	6 03	6 04	6 05	6 06	6 05	6 05	6 04	6 04	6 03	6 02	6 01	6 00	6 00	5 59	5 58	5 57	5 56	5 55	5 54	5 53	5 52	5 51	5 50	5 49	R.	2
	S.	6 03	6 05	6 06	6 07	6 07	6 08	6 08	6 07	6 07	6 07	6 06	6 06	6 05	6 05	6 04	6 03	6 02	6 02	6 01	6 01	6 00	5 59	5 58	5 57	5 56	S.	
3	R.	6 03	6 05	6 06	6 06	6 07	6 06	6 06	6 05	6 05	6 04	6 03	6 02	6 01	6 00	5 59	5 58	5 57	5 56	5 55	5 54	5 53	5 52	5 51	5 50	5 49	R.	3
	S.	6 01	6 03	6 05	6 05	6 06	6 06	6 06	6 06	6 06	6 06	6 05	6 05	6 04	6 04	6 03	6 03	6 02	6 01	6 00	6 00	5 59	5 59	5 58	5 57	5 56	S.	
4	R.	6 04	6 06	6 07	6 08	6 08	6 08	6 07	6 06	6 06	6 05	6 04	6 03	6 02	6 01	6 00	5 59	5 58	5 57	5 55	5 54	5 53	5 52	5 51	5 50	5 49	R.	4
	S.	5 59	6 02	6 03	6 04	6 04	6 05	6 05	6 05	6 05	6 05	6 04	6 04	6 03	6 03	6 03	6 02	6 01	6 01	6 00	6 00	5 59	5 58	5 58	5 57	5 56	S.	
5	R.	6 06	6 08	6 09	6 09	6 10	6 09	6 09	6 08	6 07	6 06	6 05	6 04	6 03	6 02	6 01	6 00	5 59	5 57	5 56	5 55	5 54	5 52	5 51	5 50	5 49	R.	5
	S.	5 57	6 00	6 01	6 02	6 03	6 03	6 04	6 04	6 03	6 03	6 03	6 03	6 02	6 02	6 02	6 02	6 01	6 00	6 00	6 00	5 59	5 58	5 58	5 57	5 56	S.	
6	R.	6 08	6 10	6 11	6 11	6 11	6 10	6 10	6 09	6 08	6 07	6 06	6 05	6 04	6 03	6 01	6 00	5 59	5 58	5 56	5 55	5 54	5 52	5 51	5 50	5 48	R.	6
	S.	5 56	5 58	6 00	6 01	6 02	6 02	6 03	6 03	6 02	6 02	6 02	6 02	6 02	6 02	6 01	6 01	6 00	6 00	5 59	5 59	5 59	5 58	5 58	5 57	6 56	S.	
7	R.	6 10	6 11	6 12	6 12	6 12	6 12	6 11	6 10	6 09	6 08	6 07	6 06	6 05	6 04	6 02	6 01	6 00	5 58	5 57	5 56	5 54	5 53	5 51	5 50	5 48	R.	7
	S.	5 54	5 56	5 58	5 59	6 00	6 01	6 01	6 01	6 01	6 01	6 01	6 01	6 01	6 01	6 00	6 00	6 00	5 59	5 59	5 59	5 58	5 58	5 57	5 57	5 56	S.	
8	R.	6 11	6 13	6 14	6 14	6 14	6 13	6 12	6 11	6 10	6 09	6 08	6 07	6 06	6 04	6 03	6 02	6 00	5 59	5 57	5 56	5 54	5 53	5 51	5 50	5 48	R.	8
	S.	5 52	5 55	5 57	5 58	5 59	6 00	6 00	6 00	6 00	6 00	6 00	6 00	6 00	6 00	6 00	6 00	5 59	5 59	5 59	5 59	5 58	5 58	5 57	5 57	5 56	S.	
9	R.	6 13	6 15	6 16	6 15	6 15	6 14	6 14	6 13	6 12	6 10	6 09	6 08	6 07	6 05	6 04	6 03	6 01	5 59	5 57	5 56	5 55	5 53	5 51	5 50	5 48	R.	9
	S.	5 50	5 53	5 55	5 56	5 57	5 58	5 59	5 59	5 59	5 59	5 59	5 59	5 59	5 59	5 59	5 59	5 58	5 58	5 58	5 58	5 58	5 58	5 57	5 57	5 56	S.	
10	R.	6 15	6 16	6 17	6 17	6 17	6 16	6 15	6 14	6 13	6 11	6 10	6 09	6 07	6 06	6 04	6 03	6 02	6 00	5 58	5 56	5 55	5 53	5 51	5 50	5 48	R.	10
	S.	5 49	5 51	5 53	5 55	5 56	5 57	5 58	5 58	5 58	5 58	5 58	5 59	5 58	5 58	5 58	5 58	5 58	5 58	5 58	5 58	5 58	5 58	5 57	5 57	5 56	S.	
11	R.	6 17	6 18	6 19	6 18	6 18	6 17	6 16	6 15	6 14	6 12	6 11	6 10	6 08	6 07	6 05	6 04	6 02	6 00	5 58	5 57	5 55	5 53	5 52	5 50	5 48	R.	11
	S.	5 47	5 49	5 52	5 53	5 54	5 55	5 56	5 57	5 57	5 57	5 57	5 58	5 57	5 57	5 57	5 57	5 57	5 57	5 57	5 57	5 57	5 57	5 57	5 57	5 56	S.	
12	R.	6 18	6 20	6 20	6 20	6 20	6 19	6 18	6 16	6 15	6 13	6 12	6 11	6 09	6 08	6 06	6 04	6 03	6 01	5 59	5 58	5 56	5 54	5 52	5 50	5 48	R.	12
	S.	5 45	5 48	5 50	5 52	5 53	5 54	5 55	5 55	5 56	5 56	5 56	5 57	5 57	5 57	5 57	5 57	5 57	5 57	5 57	5·57	5 57	5 57	5 57	5 57	5 56	S.	
13	R.	6 20	6 22	6 22	6 22	6 21	6 20	6 19	6 18	6 16	6 15	6 13	6 12	6 10	6 09	6 07	6 05	6 03	6 01	5 59	5 58	5 56	5 54	5 52	5 50	5 48	R.	13
	S.	5 43	5 46	5 48	5 50	5 51	5 52	5 53	5 54	5 54	5 55	5 55	5 56	5 56	5 56	5 56	5 56	5 56	5 56	5 56	5 56	5 56	5 56	5 56	5 56	5 56	S.	
14	R.	6 22	6 23	6 24	6 23	6 23	6 22	6 20	6 19	6 17	6 16	6 14	6 13	6 11	6 09	6 07	6 06	6 04	6 02	6 00	5 58	5 56	5 54	5 52	5 50	5 48	R.	14
	S.	5 42	5 44	5 46	5 48	5 50	5 51	5 52	5 53	5 53	5 54	5 54	5 55	5 55	5 55	5 55	5 56	5 56	5 56	5 56	5 56	5 56	5 56	5 56	5 56	5 56	S.	
15	R.	6 24	6 25	6 26	6 25	6 24	6 23	6 22	6 20	6 19	6 17	6 15	6 14	6 12	6 10	6 08	6 06	6 04	6 02	6 00	5 58	5 56	5 54	5 52	5 50	5 48	R.	15
	S.	5 40	5 42	5 45	5 47	5 48	5 49	5 50	5 51	5 52	5 53	5 53	5 54	5 54	5 55	5 55	5 55	5 55	5 55	5 55	5 56	5 56	5 56	5 56	5 56	5 56	S.	
16	R.	6 26	6 27	6 27	6 26	6 26	6 25	6 23	6 22	6 20	6 18	6 16	6 15	6 13	6 11	6 09	6 07	6 05	6 03	6 01	5 59	5 57	5 55	5 52	5 50	5 48	R.	16
	S.	5 38	5 40	5 43	5 45	5 47	5 48	5 49	5 50	5 51	5 52	5 52	5 53	5 53	5 54	5 54	5 55	5 55	5 55	5 55	5 56	5 56	5 56	5 56	5 56	5 56	S.	
17	R.	6 28	6 29	6 29	6 28	6 28	6 26	6 25	6 23	6 21	6 19	6 18	6 16	6 14	6 12	6 10	6 08	6 06	6 03	6 01	5 59	5 57	5 55	5 53	5 50	5 48	R.	17
	S.	5 36	5 38	5 41	5 43	5 45	5 46	5 47	5 48	5 49	5 50	5 51	5 52	5 52	5 53	5 53	5 54	5 54	5 54	5 54	5 55	5 55	5 56	5 56	5 56	5 56	S.	
18	R.	6 30	6 31	6 31	6 30	6 29	6 28	6 26	6 24	6 22	6 20	6 19	6 17	6 15	6 13	6 10	6 08	6 06	6 04	6 01	5 59	5 57	5 55	5 53	5 50	5 48	R.	18
	S.	5 34	5 37	5 40	5 42	5 43	5 45	5 46	5 47	5 48	5 49	5 50	5 51	5 51	5 52	5 52	5 53	5 53	5 54	5 54	5 55	5 55	5 56	5 56	5 56	5 56	S.	
19	R.	6 32	6 33	6 33	6 32	6 31	6 29	6 28	6 26	6 24	6 22	6 20	6 18	6 16	6 14	6 11	6 09	6 07	6 04	6 02	6 00	5 58	5 55	5 53	5 50	5 48	R.	19
	S.	5 32	5 35	5 38	5 40	5 42	5 43	5 45	5 46	5 47	5 48	5 49	5 50	5 50	5 51	5 51	5 52	5 53	5 53	5 54	5 55	5 55	5 55	5 56	5 56	5 56	S.	
20	R.	6 34	6 35	6 35	6 33	6 32	6 31	6 29	6 27	6 25	6 23	6 21	6 19	6 16	6 14	6 12	6 10	6 07	6 05	6 02	6 00	5 58	5 55	5 53	5 50	5 48	R.	20
	S.	5 30	5 33	5 36	5 38	5 40	5 42	5 43	5 45	5 46	5 47	5 48	5 49	5 49	5 50	5 51	5 52	5 52	5 53	5 53	5 54	5 55	5 55	5 56	5 56	5 56	S.	

TABLE 10.

Mean Time of Sun's Visible Rising and Setting.

South Latitude: 21° to 40°—June 22 to September 23.

[R = Local mean time of sun's visible rising. S = Local mean time of sun's visible setting.]

Lat. S.	Approx. date.	JUNE.	JULY.					AUGUST.										SEPTEMBER.									Approx. date.	Lat. S.
		22	8	12	19	24	28	2	5	9	12	16	19	22	25	28	30	2	5	8	10	13	16	18	21	23		
	Dec. N.	23° 27′	23°	22°	21°	20°	19°	18°	17°	16°	15°	14°	13°	12°	11°	10°	9°	8°	7°	6°	5°	4°	3°	2°	1°	0°	Dec. N.	
°		h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.		°
21	R.	6 36	6 37	6 37	6 35	6 34	6 32	6 30	6 28	6 26	6 24	6 22	6 20	6 17	6 15	6 13	6 11	6 08	6 05	6 03	6 01	5 58	5 56	5 53	5 51	5 48	R.	21
	S.	5 28	5 31	5 34	5 36	5 38	5 40	5 42	5 43	5 44	5 46	5 47	5 48	5 48	5 49	5 50	5 51	5 51	5 52	5 53	5 54	5 54	5 55	5 55	5 56	5 56	S.	
22	R.	6 38	6 39	6 38	6 37	6 36	6 34	6 32	6 30	6 27	6 25	6 23	6 21	6 18	6 16	6 13	6 11	6 09	6 06	6 03	6 01	5 58	5 56	5 53	5 51	5 48	R.	22
	S.	5 26	5 29	5 32	5 35	5 37	5 39	5 40	5 42	5 43	5 45	5 46	5 47	5 47	5 48	5 49	5 50	5 51	5 52	5 52	5 53	5 54	5 55	5 55	5 56	5 56	S.	
23	R.	6 40	6 41	6 40	6 39	6 37	6 35	6 33	6 31	6 29	6 26	6 24	6 22	6 19	6 17	6 14	6 12	6 09	6 06	6 04	6 02	5 59	5 56	5 53	5 51	5 48	R.	23
	S.	5 24	5 27	5 30	5 33	5 35	5 37	5 39	5 40	5 42	5 43	5 45	5 46	5 46	5 47	5 48	5 49	5 50	5 51	5 52	5 53	5 54	5 55	5 55	5 56	5 56	S.	
24	R.	6 42	6 43	6 42	6 40	6 39	6 37	6 35	6 33	6 30	6 28	6 25	6 23	6 20	6 18	6 15	6 13	6 10	6 07	6 04	6 02	5 59	5 56	5 53	5 51	5 48	R.	24
	S.	5 22	5 25	5 28	5 31	5 34	5 36	5 37	5 39	5 40	5 42	5 43	5 44	5 45	5 46	5 48	5 49	5 50	5 51	5 51	5 52	5 53	5 54	5 55	5 56	5 56	S	
25	R.	6 44	6 45	6 44	6 42	6 41	6 39	6 37	6 34	6 32	6 29	6 27	6 24	6 21	6 19	6 16	6 13	6 11	6 08	6 05	6 02	6 00	5 57	5 54	5 51	5 48	R.	25
	S.	5 20	5 23	5 26	5 29	5 32	5 34	5 36	5 37	5 39	5 40	5 42	5 43	5 44	5 46	5 47	5 48	5 49	5 50	5 51	5 52	5 53	5 54	5 55	5 56	5 56	S.	
26	R.	6 46	6 47	6 46	6 44	6 42	6 40	6 38	6 35	6 33	6 30	6 28	6 25	6 22	6 19	6 16	6 14	6 11	6 08	6 05	6 03	6 00	5 57	5 54	5 51	5 48	R.	26
	S.	5 18	5 21	5 24	5 27	5 30	5 32	5 34	5 36	5 38	5 39	5 41	5 42	5 43	5 45	5 46	5 47	5 48	5 49	5 50	5 52	5 53	5 54	5 55	5 56	5 56	S.	
27	R.	6 48	6 49	6 48	6 46	6 44	6 42	6 40	6 37	6 34	6 31	6 29	6 26	6 23	6 20	6 17	6 15	6 12	6 09	6 06	6 03	6 00	5 57	5 54	5 51	5 48	R.	27
	S.	5 15	5 18	5 22	5 25	5 28	5 31	5 33	5 35	5 36	5 38	5 40	5 41	5 42	5 44	5 45	5 47	5 48	5 49	5 50	5 51	5 52	5 54	5 55	5 56	5 57	S.	
28	R.	6 50	6 51	6 50	6 48	6 46	6 44	6 41	6 38	6 36	6 33	6 30	6 27	6 24	6 21	6 18	6 15	6 12	6 09	6 06	6 03	6 00	5 57	5 54	5 51	5 48	R.	28
	S.	5 13	5 16	5 20	5 23	5 26	5 29	5 31	5 33	5 35	5 37	5 39	5 40	5 41	5 43	5 44	5 46	5 47	5 48	5 49	5 51	5 52	5 53	5 54	5 56	5 57	S.	
29	R.	6 53	6 53	6 52	6 50	6 48	6 46	6 43	6 40	6 37	6 34	6 31	6 28	6 25	6 22	6 19	6 16	6 13	6 10	6 07	6 04	6 01	5 57	5 54	5 51	5 48	R.	29
	S.	5 11	5 14	5 18	5 21	5 24	5 27	5 29	5 31	5 33	5 35	5 37	5 39	5 40	5 42	5 43	5 45	5 46	5 48	5 49	5 51	5 52	5 53	5 54	5 56	5 57	S.	
30	R.	6 55	6 55	6 54	6 52	6 50	6 47	6 45	6 42	6 39	6 36	6 33	6 30	6 26	6 23	6 20	6 17	6 14	6 10	6 07	6 04	6 01	5 57	5 54	5 51	5 48	R.	30
	S.	5 09	5 12	5 16	5 19	5 22	5 25	5 28	5 30	5 32	5 34	5 36	5 38	5 39	5 41	5 43	5 45	5 46	5 47	5 48	5 50	5 52	5 53	5 54	5 56	5 57	S.	
31	R.	6 57	6 58	6 57	6 54	6 52	6 49	6 46	6 43	6 40	6 37	6 34	6 31	6 27	6 24	6 21	6 18	6 15	6 11	6 08	6 05	6 01	5 58	5 54	5 51	5 48	R.	31
	S.	5 06	5 10	5 14	5 17	5 20	5 23	5 26	5 28	5 30	5 32	5 34	5 36	5 38	5 40	5 42	5 44	5 45	5 46	5 48	5 50	5 51	5 53	5 54	5 56	5 57	S.	
32	R.	7 00	7 00	6 59	6 56	6 54	6 51	6 48	6 45	6 42	6 38	6 35	6 32	6 28	6 25	6 22	6 19	6 15	6 12	6 08	6 05	6 02	5 58	5 54	5 51	5 48	R.	32
	S.	5 04	5 07	5 12	5 15	5 18	5 21	5 24	5 27	5 29	5 31	5 33	5 35	5 37	5 39	5 41	5 43	5 41	5 46	5 47	5 49	5 51	5 53	5 54	5 56	5 57	S.	
33	R.	7 02	7 03	7 01	6 59	6 56	6 53	6 50	6 47	6 43	6 40	6 37	6 33	6 30	6 26	6 23	6 20	6 16	6 12	6 09	6 06	6 02	5 58	5 55	5 51	5 48	R.	33
	S.	5 01	5 05	5 09	5 13	5 16	5 19	5 22	5 25	5 27	5 30	5 32	5 34	5 36	5 38	5 40	5 42	5 43	5 45	5 47	5 49	5 50	5 52	5 54	5 55	5 57	S.	
34	R.	7 05	7 05	7 03	7 01	6 58	6 55	6 52	6 48	6 45	6 41	6 38	6 35	6 31	6 27	6 24	6 20	6 17	6 13	6 09	6 06	6 02	5 58	5 55	5 51	5 48	R.	34
	S.	4 59	5 02	5 07	5 11	5 14	5 18	5 21	5 23	5 26	5 28	5 30	5 33	5 35	5 37	5 39	5 41	5 43	5 45	5 46	5 48	5 50	5 52	5 51	5 55	5 57	S.	
35	R.	7 07	7 08	7 06	7 03	7 00	6 57	6 54	6 50	6 47	6 43	6 40	6 36	6 32	6 29	6 25	6 21	6 18	6 14	6 10	6 07	6 03	5 59	5 55	5 51	5 48	R.	35
	S.	4 56	5 00	5 05	5 09	5 12	5 16	5 19	5 21	5 24	5 26	5 29	5 31	5 33	5 36	5 38	5 40	5 42	5 44	5 46	5 48	5 50	5 52	5 53	5 56	5 57	S.	
36	R.	7 10	7 10	7 08	7 05	7 02	6 59	6 56	6 52	6 48	6 45	6 41	6 37	6 33	6 30	6 26	6 22	6 18	6 14	6 10	6 07	6 03	5 59	5 55	5 51	5 48	R.	36
	S.	4 54	4 57	5 02	5 06	5 10	5 14	5 17	5 20	5 22	5 25	5 27	5 30	5 32	5 35	5 37	5 39	5 41	5 43	5 45	5 47	5 49	5 51	5 53	5 55	5 57	S.	
37	R.	7 13	7 13	7 11	7 08	7 05	7 01	6 58	6 54	6 50	6 46	6 43	6 39	6 35	6 31	6 27	6 23	6 19	6 15	6 11	6 08	6 04	6 00	5 56	5 52	5 48	R.	37
	S.	4 51	4 55	5 00	5 04	5 08	5 11	5 15	5 18	5 20	5 23	5 26	5 29	5 31	5 34	5 36	5 38	5 40	5 42	5 44	5 47	5 49	5 51	5 53	5 55	5 57	S.	
38	R.	7 16	7 16	7 13	7 10	7 07	7 03	7 00	6 56	6 52	6 48	6 44	6 40	6 36	6 32	6 28	6 24	6 20	6 16	6 12	6 08	6 04	6 00	5 56	5 52	5 47	R.	38
	S.	4 48	4 52	4 57	5 01	5 05	5 09	5 13	5 16	5 19	5 22	5 24	5 27	5 30	5 33	5 35	5 37	5 40	5 42	5 44	5 46	5 49	5 51	5 53	5 55	5 57	S.	
39	R.	7 19	7 19	7 16	7 13	7 10	7 06	7 02	6 58	6 54	6 50	6 46	6 42	6 37	6 33	6 29	6 25	6 21	6 17	6 13	6 09	6 04	6 00	5 56	5 52	5 47	R.	39
	S.	4 45	4 49	4 54	4 59	5 03	5 07	5 10	5 14	5 17	5 20	5 23	5 26	5 28	5 31	5 34	5 36	5 39	5 41	5 43	5 46	5 48	5 51	5 53	5 55	5 57	S.	
40	R.	7 22	7 22	7 19	7 16	7 12	7 08	7 04	7 00	6 56	6 51	6 47	6 43	6 39	6 34	6 30	6 26	6 22	6 18	6 13	6 09	6 05	6 00	5 56	5 52	5 47	R.	40
	S.	4 42	4 46	4 52	4 56	5 00	5 04	5 08	5 12	5 15	5 18	5 21	5 24	5 27	5 30	5 33	5 35	5 38	5 40	5 42	5 45	5 48	5 50	5 53	5 55	5 57	S.	

TABLE 10.

Mean Time of Sun's Visible Rising and Setting.

South Latitude: 41° to 60°—June 22 to September 23.

[R = Local mean time of sun's visible rising. S = Local mean time of sun's visible setting.]

Lat. S.	Approx. date.	JUNE.	JULY.					AUGUST.										SEPTEMBER.									Approx. date.	Lat. S.
		22	3	12	19	24	28	2	5	9	12	16	19	22	25	28	30	2	5	8	10	13	16	18	21	23		
	Dec. N.	23° 27′	23°	22°	21°	20°	19°	18°	17°	16°	15°	14°	13°	12°	11°	10°	9°	8°	7°	6°	5°	4°	3°	2°	1°	0°	Dec. N.	
°		h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.		°
41	R.	7 25	7 25	7 22	7 18	7 15	7 11	7 07	7 02	6 58	6 53	6 49	6 45	6 40	6 36	6 31	6 27	6 23	6 18	6 14	6 10	6 05	6 01	5 56	5 52	5 47	R.	41
	S.	4 39	4 43	4 49	4 53	4 58	5 02	5 06	5 09	5 13	5 16	5 19	5 22	5 25	5 28	5 31	5 34	5 37	5 39	5 42	5 45	5 47	5 50	5 52	5 55	5 57	S.	
42	R.	7 28	7 28	7 25	7 21	7 17	7 13	7 09	7 04	7 00	6 55	6 51	6 46	6 42	6 37	6 32	6 28	6 24	6 19	6 14	6 10	6 06	6 01	5 56	5 52	5 47	R.	42
	S.	4 36	4 40	4 46	4 51	4 55	5 00	5 04	5 07	5 11	5 14	5 18	5 21	5 24	5 27	5 30	5 33	5 36	5 39	5 41	5 44	5 47	5 50	5 52	5 55	5 57	S.	
43	R.	7 31	7 31	7 28	7 24	7 20	7 15	7 11	7 06	7 02	6 57	6 53	6 48	6 43	6 39	6 34	6 29	6 25	6 20	6 15	6 11	6 06	6 01	5 57	5 52	5 47	R.	43
	S.	4 32	4 37	4 43	4 48	4 53	4 57	5 01	5 05	5 09	5 12	5 16	5 19	5 22	5 26	5 29	5 32	5 35	5 38	5 41	5 44	5 46	5 49	5 52	5 55	5 57	S.	
44	R.	7 35	7 34	7 31	7 27	7 23	7 18	7 14	7 09	7 04	6 59	6 54	6 50	6 45	6 40	6 35	6 31	6 26	6 21	6 16	6 11	6 06	6 01	5 57	5 52	5 47	R.	44
	S.	4 29	4 33	4 40	4 45	4 50	4 54	4 59	5 03	5 07	5 10	5 14	5 18	5 21	5 24	5 27	5 31	5 34	5 37	5 40	5 43	5 46	5 49	5 52	5 55	5 58	S.	
45	R.	7 38	7 38	7 34	7 30	7 26	7 21	7 16	7 11	7 06	7 01	6 56	6 51	6 46	6 41	6 36	6 32	6 27	6 22	6 17	6 12	6 07	6 02	5 57	5 52	5 47	R.	45
	S.	4 25	4 30	4 36	4 42	4 47	4 52	4 56	5 00	5 04	5 08	5 12	5 16	5 19	5 23	5 26	5 30	5 33	5 36	5 39	5 43	5 46	5 49	5 52	5 55	5 58	S.	
46	R.	7 42	7 41	7 38	7 33	7 29	7 24	7 19	7 14	7 08	7 03	6 58	6 53	6 48	6 43	6 38	6 33	6 28	6 22	6 17	6 12	6 07	6 02	5 57	5 52	5 47	R.	46
	S.	4 22	4 26	4 33	4 38	4 44	4 49	4 54	4 58	5 02	5 06	5 10	5 14	5 18	5 21	5 25	5 29	5 32	5 35	5 38	5 42	5 45	5 49	5 52	5 55	5 58	S.	
47	R.	7 46	7 45	7 41	7 37	7 32	7 27	7 22	7 16	7 11	7 05	7 00	6 55	6 50	6 45	6 39	6 34	6 29	6 23	6 18	6 13	6 08	6 02	5 57	5 52	5 47	R.	47
	S.	4 18	4 22	4 29	4 35	4 41	4 46	4 51	4 55	5 00	5 04	5 08	5 12	5 16	5 20	5 23	5 27	5 31	5 34	5 38	5 42	5 45	5 48	5 51	5 55	5 58	S.	
48	R.	7 50	7 49	7 45	7 40	7 35	7 30	7 25	7 19	7 13	7 08	7 02	6 57	6 51	6 46	6 41	6 35	6 30	6 24	6 19	6 14	6 08	6 03	5 57	5 52	5 47	R.	48
	S.	4 14	4 18	4 25	4 31	4 37	4 43	4 48	4 53	4 57	5 02	5 06	5 10	5 14	5 18	5 22	5 26	5 30	5 33	5 37	5 41	5 44	5 48	5 51	5 55	5 58	S.	
49	R.	7 54	7 53	7 49	7 44	7 39	7 33	7 28	7 22	7 16	7 10	7 05	6 59	6 53	6 48	6 42	6 37	6 31	6 25	6 19	6 14	6 09	6 03	5 57	5 52	5 47	R.	49
	S.	4 09	4 14	4 21	4 28	4 34	4 39	4 45	4 50	4 54	4 59	5 04	5 08	5 12	5 17	5 21	5 25	5 28	5 32	5 36	5 40	5 44	5 47	5 51	5 55	5 58	S.	
50	R.	7 59	7 58	7 53	7 48	7 43	7 37	7 31	7 25	7 19	7 13	7 07	7 01	6 55	6 50	6 44	6 38	6 32	6 26	6 20	6 15	6 09	6 04	5 58	5 52	5 46	R.	50
	S.	4 05	4 10	4 17	4 24	4 30	4 36	4 42	4 47	4 52	4 57	5 01	5 06	5 10	5 15	5 19	5 23	5 27	5 31	5 35	5 39	5 43	5 47	5 51	5 55	5 58	S.	
51	R.	8 04	8 02	7 58	7 52	7 46	7 40	7 34	7 28	7 22	7 16	7 10	7 04	6 57	6 51	6 45	6 39	6 33	6 27	6 21	6 16	6 10	6 04	5 58	5 52	5 46	R.	51
	S.	4 00	4 05	4 13	4 20	4 26	4 32	4 38	4 44	4 49	4 54	4 59	5 04	5 08	5 13	5 17	5 22	5 26	5 30	5 34	5 38	5 42	5 46	5 50	5 54	5 58	S.	
52	R.	8 09	8 07	8 02	7 56	7 50	7 44	7 38	7 31	7 25	7 18	7 12	7 06	6 59	6 53	6 47	6 41	6 35	6 29	6 23	6 17	6 11	6 04	5 58	5 52	5 46	R.	52
	S.	3 55	4 00	4 08	4 15	4 22	4 28	4 34	4 40	4 46	4 51	4 56	5 01	5 06	5 11	5 16	5 20	5 25	5 29	5 33	5 38	5 42	5 46	5 50	5 54	5 58	S.	
53	R.	8 14	8 13	8 07	8 01	7 54	7 48	7 41	7 35	7 28	7 21	7 15	7 08	7 02	6 55	6 49	6 43	6 36	6 30	6 24	6 18	6 11	6 05	5 59	5 52	5 46	R.	53
	S.	3 49	3 55	4 03	4 11	4 18	4 25	4 31	4 37	4 43	4 48	4 54	4 59	5 04	5 09	5 14	5 19	5 23	5 28	5 32	5 37	5 41	5 46	5 50	5 54	5 58	S.	
54	R.	8 20	8 18	8 12	8 06	7 59	7 52	7 45	7 38	7 31	7 24	7 18	7 11	7 04	6 57	6 51	6 44	6 38	6 31	6 25	6 18	6 12	6 05	5 59	5 52	5 46	R.	54
	S.	3 44	3 49	3 58	4 06	4 14	4 21	4 27	4 33	4 39	4 45	4 51	4 57	5 02	5 07	5 12	5 17	5 22	5 27	5 31	5 36	5 41	5 45	5 50	5 54	5 59	S.	
55	R.	8 26	8 24	8 18	8 11	8 04	7 56	7 49	7 42	7 35	7 28	7 21	7 14	7 07	7 00	6 53	6 46	6 39	6 32	6 26	6 19	6 13	6 06	5 59	5 52	5 46	R.	55
	S.	3 38	3 44	3 53	4 01	4 09	4 16	4 23	4 30	4 36	4 42	4 48	4 54	4 59	5 05	5 10	5 15	5 20	5 25	5 30	5 35	5 40	5 45	5 50	5 54	5 59	S.	
56	R.	8 33	8 30	8 24	8 16	8 09	8 01	7 54	7 46	7 38	7 31	7 24	7 17	7 09	7 02	6 55	6 48	6 41	6 34	6 27	6 20	6 13	6 06	5 59	5 52	5 45	R.	56
	S.	3 31	3 37	3 47	3 55	4 03	4 11	4 19	4 26	4 32	4 39	4 45	4 51	4 56	5 02	5 08	5 13	5 19	5 24	5 29	5 34	5 39	5 44	5 49	5 54	5 59	S.	
57	R.	8 40	8 37	8 30	8 22	8 14	8 06	7 58	7 50	7 42	7 35	7 27	7 20	7 12	7 05	6 57	6 50	6 43	6 35	6 28	6 21	6 14	6 07	6 00	5 52	5 45	R.	57
	S.	3 24	3 30	3 41	3 50	3 58	4 06	4 14	4 21	4 28	4 35	4 41	4 48	4 54	5 00	5 06	5 11	5 17	5 22	5 27	5 33	5 38	5 44	5 49	5 54	5 59	S.	
58	R.	8 47	8 44	8 37	8 28	8 20	8 11	8 03	7 55	7 46	7 38	7 31	7 23	7 15	7 07	6 59	6 52	6 44	6 37	6 29	6 22	6 15	6 07	6 00	5 52	5 45	R.	58
	S.	3 16	3 23	3 34	3 43	3 52	4 01	4 09	4 17	4 24	4 31	4 38	4 45	4 51	4 57	5 03	5 09	5 15	5 21	5 26	5 32	5 38	5 43	5 49	5 54	5 59	S.	
59	R.	8 55	8 52	8 44	8 35	8 26	8 17	8 08	8 00	7 51	7 42	7 34	7 26	7 18	7 10	7 02	6 54	6 46	6 38	6 31	6 23	6 16	6 08	6 00	5 52	5 45	R.	59
	S.	3 08	3 15	3 27	3 37	3 47	3 56	4 04	4 12	4 20	4 27	4 34	4 41	4 48	4 55	5 01	5 07	5 13	5 19	5 25	5 31	5 37	5 43	5 48	5 54	6 00	S.	
60	R.	9 04	9 01	8 52	8 42	8 33	8 23	8 14	8 06	7 56	7 47	7 38	7 30	7 21	7 13	7 04	6 56	6 48	6 40	6 32	6 25	6 17	6 09	6 01	5 53	5 45	R.	60
	S.	2 59	3 06	3 19	3 30	3 40	3 49	3 58	4 07	4 15	4 23	4 30	4 38	4 45	4 52	4 58	5 05	5 11	5 17	5 23	5 30	5 36	5 42	5 48	5 54	6 00	S.	

TABLE 10.

Mean Time of Sun's Visible Rising and Setting.

South latitude: 0° to 20°—September 23 to December 22.

[R=Local mean time of sun's visible rising. S=Local mean time of sun's visible setting.]

Lat. S.	Approx. date.	SEPTEMBER.			OCTOBER.												NOVEMBER.							DECEMBER.			Approx. date.	Lat. S.
		23	26	28	1	4	6	9	11	14	17	19	22	25	28	31	3	6	10	14	17	22	27	3	11	22		
	Dec. S.	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	13°	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	23° 27′	Dec. S.	
°		h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.		°
0	R.	5 49	5 48	5 47	5 46	5 45	5 44	5 44	5 43	5 42	5 42	5 41	5 41	5 40	5 40	5 40	5 40	5 40	5 40	5 40	5 41	5 42	5 44	5 46	5 49	5 54	R.	0
	S.	5 56	5 55	5 55	5 54	5 53	5 52	5 52	5 51	5 50	5 50	5 49	5 49	5 48	5 48	5 48	5 48	5 48	5 48	5 48	5 49	5 50	5 52	5 54	5 57	6 02	S.	
1	R.	5 49	5 48	5 47	5 46	5 45	5 44	5 44	5 43	5 42	5 41	5 41	5 40	5 40	5 39	5 39	5 39	5 39	5 39	5 39	5 40	5 41	5 42	5 44	5 48	5 53	R.	1
	S.	5 56	5 55	5 55	5 54	5 53	5 52	5 52	5 51	5 50	5 50	5 50	5 49	5 49	5 49	5 49	5 49	5 49	5 49	5 50	5 51	5 52	5 53	5 55	5 59	6 04	S.	
2	R.	5 49	5 48	5 47	5 46	5 45	5 44	5 44	5 43	5 42	5 41	5 40	5 40	5 39	5 38	5 38	5 38	5 38	5 38	5 38	5 39	5 40	5 41	5 43	5 46	5 51	R.	2
	S.	5 56	5 55	5 55	5 54	5 53	5 52	5 52	5 51	5 51	5 51	5 50	5 50	5 49	5 49	5 50	5 50	5 50	5 50	5 51	5 52	5 53	5 55	5 57	6 00	6 05	S.	
3	R.	5 49	5 48	5 47	5 46	5 45	5 44	5 43	5 42	5 41	5 40	5 39	5 39	5 38	5 37	5 37	5 37	5 37	5 37	5 37	5 37	5 38	5 39	5 41	5 44	5 49	R.	3
	S.	5 56	5 55	5 55	5 54	5 54	5 53	5 52	5 51	5 51	5 51	5 51	5 51	5 50	5 50	5 51	5 51	5 51	5 51	5 52	5 53	5 55	5 56	5 58	6 02	6 07	S.	
4	R.	5 49	5 48	5 47	5 46	5 45	5 44	5 43	5 42	5 41	5 40	5 39	5 38	5 37	5 36	5 36	5 36	5 36	5 35	5 35	5 36	5 36	5 38	5 39	5 43	5 48	R.	4
	S.	5 56	5 55	5 55	5 54	5 54	5 53	5 53	5 52	5 52	5 52	5 52	5 51	5 51	5 51	5 52	5 52	5 52	5 52	5 53	5 55	5 56	5 58	6 00	6 04	6 09	S.	
5	R.	5 49	5 48	5 46	5 45	5 44	5 43	5 42	5 41	5 40	5 39	5 38	5 37	5 36	5 35	5 35	5 35	5 34	5 34	5 34	5 34	5 35	5 36	5 38	5 41	5 46	R.	5
	S.	5 56	5 55	5 55	5 54	5 54	5 53	5 53	5 53	5 53	5 53	5 53	5 52	5 52	5 52	5 53	5 53	5 53	5 54	5 55	5 56	5 58	5 59	6 02	6 05	6 11	S.	
6	R.	5 48	5 47	5 46	5 45	5 44	5 43	5 42	5 40	3 39	5 38	5 37	5 37	5 36	5 35	5 34	5 34	5 33	5 33	5 33	5 33	5 33	5 35	5 36	5 40	5 44	R.	6
	S.	5 56	5 55	5 55	5 54	5 54	5 54	5 54	5 53	5 53	5 53	5 53	5 53	5 53	5 53	5 54	5 54	5 54	5 55	5 56	5 57	5 59	6 01	6 03	6 07	6 12	S.	
7	R.	5 48	5 47	5 46	5 45	5 44	5 42	5 41	5 40	5 39	5 38	5 37	5 36	5 35	5 34	5 33	5 32	5 32	5 31	5 31	5 32	5 32	5 33	5 34	5 38	5 42	R.	7
	S.	5 56	5 55	5 55	5 55	5 55	5 54	5 54	5 54	5 54	5 54	5 54	5 54	5 54	5 54	5 55	5 55	5 56	5 56	5 57	5 59	6 01	6 03	6 05	6 09	6 14	S.	
8	R.	5 48	5 47	5 46	5 45	5 43	5 42	5 41	5 39	5 38	5 37	5 36	5 35	5 34	5 33	5 32	5 31	5 31	5 30	5 30	5 30	5 30	5 31	5 33	5 36	5 41	R.	8
	S.	5 56	5 55	5 55	5 55	5 55	5 55	5 55	5 54	5 54	5 54	5 55	5 55	5 55	5 55	5 56	5 56	5 57	5 58	5 59	6 00	6 02	6 04	6 07	6 11	6 16	S.	
9	R.	5 48	5 47	5 46	5 44	5 43	5 41	5 40	5 39	5 37	5 36	5 35	5 34	5 33	5 32	5 31	5 30	5 29	5 29	5 28	5 29	5 29	5 30	5 31	5 34	5 39	R.	9
	S.	5 56	5 56	5 56	5 55	5 55	5 55	5 55	5 55	5 55	5 55	5 56	5 56	5 56	5 56	5 57	5 57	5 58	5 59	6 00	6 02	6 04	6 06	6 09	6 13	6 18	S.	
10	R.	5 48	5 47	5 46	5 44	5 43	5 41	5 40	5 38	5 37	5 36	5 34	5 33	5 32	5 31	5 30	5 29	5 28	5 28	5 27	5 27	5 27	5 28	5 29	5 32	5 37	R.	10
	S.	5 56	5 56	5 56	5 56	5 56	5 56	5 56	5 56	5 56	5 56	5 56	5 56	5 56	5 57	5 58	5 58	5 59	6 00	6 01	6 03	6 05	6 07	6 10	6 14	6 19	S.	
11	R.	5 48	5 47	5 46	5 44	5 42	5 41	5 39	5 37	5 36	5 35	5 33	5 32	5 31	5 30	5 29	5 28	5 27	5 26	5 26	5 26	5 26	5 27	5 28	5 30	5 35	R.	11
	S.	5 56	5 56	5 56	5 56	5 56	5 56	5 56	5 56	5 56	5 57	5 57	5 57	5 57	5 58	5 59	5 59	6 00	6 01	6 03	6 05	6 07	6 09	6 12	6 16	6 21	S.	
12	R.	5 48	5 47	5 46	5 44	5 42	5 40	5 39	5 37	5 36	5 34	5 33	5 32	5 30	5 29	5 28	5 27	5 26	5 25	5 25	5 25	5 25	5 25	5 26	5 29	5 33	R.	12
	S.	5 56	5 56	5 56	5 56	5 56	5 56	5 57	5 57	5 57	5 57	5 58	5 58	5 58	5 59	6 00	6 00	6 01	6 02	6 04	6 06	6 08	6 10	6 13	6 18	6 23	S.	
13	R.	5 48	5 47	5 45	5 43	5 42	5 40	5 38	5 36	5 35	5 33	5 32	5 31	5 29	5 28	5 27	5 26	5 25	5 24	5 23	5 23	5 23	5 24	5 24	5 27	5 31	R.	13
	S.	5 56	5 56	5 56	5 56	5 57	5 57	5 57	5 57	5 58	5 58	5 59	5 59	5 59	6 00	6 01	6 02	6 03	6 04	6 05	6 07	6 10	6 12	6 15	6 20	6 25	S.	
14	R.	5 48	5 47	5 45	5 43	5 42	5 40	5 38	5 36	5 34	5 33	5 31	5 30	5 28	5 27	5 26	5 25	5 24	5 23	5 22	5 22	5 21	5 22	5 23	5 25	5 29	R.	14
	S.	5 56	5 56	5 56	5 56	5 57	5 57	5 58	5 58	5 58	5 59	5 59	6 00	6 00	6 01	6 02	6 03	6 04	6 05	6 07	6 09	6 11	6 14	6 17	6 22	6 27	S.	
15	R.	5 48	5 46	5 45	5 43	5 41	5 39	5 37	5 35	5 34	5 32	5 30	5 29	5 27	5 26	5 25	5 24	5 22	5 21	5 20	5 20	5 20	5 20	5 21	5 23	5 27	R.	15
	S.	5 56	5 56	5 57	5 57	5 57	5 57	5 58	5 58	5 59	5 59	6 00	6 01	6 01	6 02	6 03	6 04	6 05	6 06	6 08	6 10	6 13	6 15	6 19	6 24	6 29	S.	
16	R.	5 48	5 46	5 45	5 43	5 41	5 39	5 37	5 35	5 33	5 32	5 30	5 28	5 26	5 25	5 24	5 23	5 21	5 20	5 19	5 19	5 19	5 19	5 19	5 21	5 25	R.	16
	S.	5 56	5 56	5 57	5 57	5 58	5 58	5 59	5 59	5 59	6 00	6 01	6 01	6 02	6 03	6 04	6 05	6 06	6 08	6 10	6 12	6 14	6 17	6 20	6 25	6 31	S.	
17	R.	5 48	5 46	5 45	5 42	5 40	5 38	5 36	5 34	5 32	5 31	5 29	5 27	5 25	5 24	5 22	5 21	5 20	5 18	5 17	5 17	5 17	5 17	5 17	5 19	5 23	R.	17
	S.	5 56	5 56	5 57	5 57	5 58	5 58	5 59	5 59	6 00	6 01	6 02	6 02	6 03	6 04	6 05	6 06	6 08	6 09	6 11	6 14	6 16	6 19	6 22	6 27	6 33	S.	
18	R.	5 48	5 46	5 45	5 42	5 40	5 38	5 36	5 34	5 32	5 30	5 28	5 26	5 24	5 23	5 21	5 20	5 19	5 17	5 16	5 15	5 15	5 15	5 16	5 18	5 21	R.	18
	S.	5 56	5 56	5 57	5 57	5 58	5 58	5 59	6 00	6 01	6 01	6 02	6 03	6 04	6 05	6 06	6 07	6 09	6 11	6 13	6 15	6 18	6 20	6 24	6 29	6 35	S.	
19	R.	5 48	5 46	5 44	5 42	5 40	5 38	5 36	5 33	5 31	5 29	5 27	5 25	5 23	5 22	5 20	5 19	5 17	5 16	5 14	5 14	5 13	5 13	5 14	5 16	5 19	R.	19
	S.	5 56	5 56	5 57	5 58	5 59	5 59	6 00	6 00	6 01	6 02	6 03	6 04	6 05	6 06	6 07	6 09	6 10	6 12	6 14	6 17	6 19	6 22	6 26	6 31	6 37	S.	
20	R.	5 48	5 46	5 44	5 42	5 40	5 37	5 35	5 33	5 31	5 29	5 27	5 25	5 22	5 21	5 19	5 18	5 16	5 15	5 13	5 12	5 12	5 12	5 12	5 14	5 17	R.	20
	S.	5 56	5 56	5 57	5 58	5 59	5 59	6 00	6 01	6 02	6 03	6 04	6 05	6 06	6 07	6 08	6 10	6 12	6 14	6 16	6 18	6 21	6 24	6 28	6 33	6 39	S.	

TABLE 10.

Mean Time of Sun's Visible Rising and Setting.

South latitude: 21° to 40°—September 23 to December 22.

[R—Local mean time of sun's visible rising. S—Local mean time of sun's visible setting.]

Lat. S.	Approx. date.	SEPTEMBER.			OCTOBER.												NOVEMBER.							DECEMBER.			Approx. date.	Lat. S.
		23	26	28	1	4	6	9	11	14	17	19	22	25	28	31	3	6	10	14	17	22	27	3	11	22		
	Dec. S.	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	13°	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	23° 27′	Dec. S.	
°		h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.		°
21	R.	5 48	5 46	5 44	5 41	5 39	5 37	5 35	5 32	5 30	5 28	5 26	5 24	5 21	5 19	5 18	5 16	5 14	5 13	5 12	5 11	5 10	5 10	5 10	5 11	5 15	R.	21
	S.	5 56	5 57	5 58	5 58	5 59	6 00	6 01	6 01	6 03	6 04	6 05	6 06	6 07	6 08	6 10	6 11	6 13	6 15	6 17	6 20	6 23	6 26	6 30	6 35	6 41	S.	
22	R.	5 48	5 46	5 44	5 41	5 39	5 36	5 34	5 32	5 29	5 27	5 25	5 23	5 20	5 18	5 17	5 15	5 13	5 11	5 10	5 09	5 08	5 08	5 08	5 09	5 13	R.	22
	S.	5 56	5 57	5 58	5 58	5 59	6 00	6 01	6 02	6 03	6 04	6 05	6 07	6 08	6 09	6 11	6 12	6 14	6 16	6 19	6 21	6 24	6 28	6 32	6 37	6 43	S.	
23	R.	5 48	5 46	5 44	5 41	5 39	5 36	5 34	5 31	5 29	5 27	5 24	5 22	5 19	5 17	5 15	5 14	5 12	5 10	5 08	5 07	5 06	5 06	5 06	5 07	5 11	R.	23
	S.	5 56	5 57	5 58	5 59	6 00	6 01	6 02	6 03	6 04	6 05	6 06	6 08	6 09	6 10	6 12	6 14	6 16	6 18	6 20	6 23	6 26	6 30	6 34	6 39	6 45	S.	
24	R.	5 48	5 46	5 44	5 41	5 38	5 35	5 33	5 30	5 28	5 26	5 23	5 21	5 18	5 16	5 14	5 12	5 10	5 08	5 07	5 06	5 05	5 04	5 04	5 05	5 09	R.	24
	S.	5 56	5 57	5 58	5 59	6 00	6 01	6 02	6 03	6 04	6 06	6 07	6 09	6 10	6 11	6 13	6 15	6 17	6 19	6 22	6 25	6 28	6 31	6 36	6 41	6 47	S.	
25	R.	5 48	5 46	5 43	5 40	5 38	5 35	5 33	5 30	5 27	5 25	5 22	5 20	5 17	5 15	5 13	5 11	5 09	5 07	5 05	5 04	5 03	5 02	5 02	5 03	5 07	R.	25
	S.	5 56	5 57	5 58	5 59	6 01	6 02	6 03	6 04	6 05	6 07	6 08	6 10	6 11	6 13	6 15	6 17	6 19	6 21	6 24	6 27	6 30	6 33	6 38	6 44	6 50	S.	
26	R.	5 48	5 45	5 43	5 40	5 38	5 35	5 32	5 29	5 27	5 24	5 21	5 19	5 16	5 14	5 12	5 10	5 07	5 05	5 03	5 02	5 01	5 00	5 00	5 01	5 05	R.	26
	S.	5 56	5 57	5 58	5 59	6 01	6 02	6 03	6 04	6 06	6 07	6 09	6 11	6 12	6 14	6 16	6 18	6 20	6 22	6 25	6 28	6 31	6 35	6 40	6 46	6 52	S.	
27	R.	5 48	5 45	5 43	5 40	5 37	5 34	5 32	5 29	5 26	5 23	5 20	5 18	5 15	5 13	5 10	5 08	5 06	5 04	5 02	5 01	4 59	4 58	4 58	4 59	5 02	R.	27
	S.	5 57	5 58	5 59	6 00	6 01	6 02	6 04	6 05	6 07	6 08	6 10	6 12	6 13	6 15	6 17	6 19	6 22	6 24	6 27	6 30	6 33	6 37	6 42	6 48	6 54	S.	
28	R.	5 48	5 45	5 42	5 39	5 37	5 34	5 31	5 28	5 25	5 22	5 19	5 17	5 14	5 11	5 09	5 07	5 04	5 02	5 00	4 59	4 57	4 56	4 56	4 57	5 00	R.	28
	S.	5 57	5 58	5 59	6 00	6 02	6 03	6 04	6 06	6 08	6 09	6 11	6 13	6 14	6 16	6 19	6 21	6 23	6 25	6 28	6 31	6 35	6 39	6 44	6 50	6 56	S.	
29	R.	5 48	5 45	5 42	5 39	5 36	5 33	5 30	5 27	5 24	5 21	5 18	5 16	5 13	5 10	5 07	5 05	5 03	5 00	4 58	4 57	4 55	4 54	4 53	4 54	4 58	R.	29
	S.	5 57	5 58	5 59	6 00	6 02	6 03	6 05	6 07	6 09	6 10	6 12	6 14	6 16	6 18	6 20	6 22	6 25	6 27	6 30	6 33	6 37	6 41	6 46	6 52	6 59	S.	
30	R.	5 48	5 45	5 42	5 39	5 36	5 33	5 30	5 26	5 23	5 20	5 17	5 15	5 12	5 09	5 06	5 04	5 01	4 59	4 57	4 55	4 53	4 52	4 51	4 52	4 55	R.	30
	S.	5 57	5 58	5 59	6 01	6 02	6 04	6 06	6 07	6 09	6 11	6 13	6 15	6 17	6 19	6 21	6 24	6 26	6 29	6 32	6 35	6 39	6 43	6 48	6 55	7 01	S.	
31	R.	5 48	5 45	5 42	5 39	5 36	5 32	5 29	5 26	5 22	5 19	5 16	5 13	5 10	5 07	5 05	5 02	5 00	4 57	4 55	4 53	4 51	4 50	4 49	4 49	4 53	R.	31
	S.	5 57	5 58	6 00	6 01	6 03	6 04	6 06	6 08	6 10	6 12	6 14	6 16	6 18	6 20	6 23	6 25	6 28	6 31	6 34	6 37	6 41	6 46	6 51	6 57	7 04	S.	
32	R.	5 48	5 44	5 41	5 38	5 35	5 32	5 29	5 25	5 22	5 18	5 15	5 12	5 09	5 06	5 03	5 01	4 58	4 55	4 53	4 51	4 49	4 48	4 46	4 47	4 50	R.	32
	S.	5 57	5 58	6 00	6 01	6 03	6 05	6 07	6 09	6 11	6 13	6 15	6 17	6 19	6 21	6 24	6 27	6 30	6 33	6 36	6 39	6 43	6 48	6 53	7 00	7 06	S.	
33	R.	5 48	5 44	5 41	5 38	5 35	5 31	5 28	5 24	5 21	5 17	5 14	5 11	5 08	5 05	5 02	4 59	4 56	4 53	4 51	4 49	4 47	4 45	4 44	4 41	4 48	R.	33
	S.	5 57	5 58	6 00	6 02	6 04	6 06	6 08	6 10	6 12	6 14	6 16	6 18	6 21	6 23	6 26	6 28	6 31	6 34	6 38	6 42	6 46	6 50	6 56	7 02	7 09	S.	
34	R.	5 48	5 44	5 41	5 37	5 34	5 30	5 27	5 23	5 20	5 16	5 13	5 10	5 07	5 03	5 00	4 57	4 54	4 51	4 49	4 47	4 45	4 43	4 41	4 42	4 45	R.	34
	S.	5 57	5 58	6 00	6 02	6 04	6 06	6 08	6 10	6 12	6 15	6 17	6 19	6 22	6 24	6 27	6 30	6 33	6 36	6 40	6 41	6 48	6 53	6 58	7 04	7 11	S.	
35	R.	5 48	5 44	5 41	5 37	5 34	5 30	5 26	5 23	5 19	5 15	5 12	5 09	5 05	5 02	4 59	4 56	4 53	4 50	4 47	4 45	4 42	4 40	4 39	4 39	4 42	R.	35
	S.	5 57	5 58	6 01	6 03	6 05	6 07	6 09	6 11	6 13	6 16	6 18	6 21	6 23	6 26	6 29	6 32	6 35	6 38	6 42	6 46	6 50	6 55	7 01	7 07	7 14	S.	
36	R.	5 48	5 44	5 41	5 37	5 33	5 29	5 26	5 22	5 18	5 14	5 11	5 08	5 04	5 00	4 57	4 54	4 51	4 48	4 45	4 42	4 40	4 38	4 36	4 36	4 39	R.	36
	S.	5 57	5 59	6 01	6 03	6 05	6 07	6 10	6 12	6 14	6 17	6 19	6 22	6 25	6 27	6 30	6 33	6 37	6 40	6 44	6 48	6 53	6 58	7 03	7 10	7 17	S.	
37	R.	5 48	5 44	5 40	5 36	5 33	5 28	5 25	5 21	5 17	5 13	5 10	5 06	5 02	4 59	4 55	4 52	4 49	4 46	4 43	4 40	4 37	4 35	4 34	4 33	4 36	R.	37
	S.	5 57	5 59	6 01	6 03	6 06	6 08	6 11	6 13	6 15	6 18	6 21	6 23	6 26	6 29	6 32	6 35	6 39	6 42	6 46	6 51	6 55	7 00	7 06	7 13	7 20	S.	
38	R.	5 47	5 44	5 40	5 36	5 32	5 28	5 24	5 20	5 16	5 12	5 09	5 05	5 01	4 57	4 54	4 50	4 47	4 44	4 41	4 38	4 35	4 33	4 31	4 30	4 33	R.	38
	S.	5 57	5 59	6 02	6 04	6 06	6 09	6 11	6 13	6 16	6 19	6 22	6 25	6 28	6 31	6 34	6 37	6 41	6 44	6 48	6 53	6 58	7 03	7 09	7 16	7 23	S.	
39	R.	5 47	5 43	5 39	5 35	5 31	5 27	5 23	5 19	5 15	5 11	5 07	5 03	4 59	4 55	4 52	4 48	4 45	4 41	4 38	4 35	4 32	4 30	4 28	4 27	4 30	R.	39
	S.	5 57	5 59	6 02	6 04	6 07	6 09	6 12	6 14	6 17	6 20	6 23	6 26	6 29	6 32	6 36	6 39	6 43	6 47	6 51	6 55	7 00	7 06	7 12	7 19	7 26	S.	
40	R.	5 47	5 43	5 39	5 35	5 31	5 27	5 23	5 18	5 14	5 10	5 06	5 02	4 58	4 54	4 50	4 47	4 43	4 39	4 36	4 33	4 30	4 27	4 25	4 24	4 27	R.	40
	S.	5 57	5 59	6 02	6 05	6 07	6 10	6 13	6 15	6 18	6 21	6 24	6 27	6 31	6 34	6 37	6 41	6 45	6 49	6 53	6 58	7 03	7 09	7 15	7 22	7 29	S.	

TABLE 10.

Mean Time of Sun's Visible Rising and Setting.

South Latitude: 41° to 60°—September 23 to December 22.

[R=Local mean time of sun's visible rising. S=Local mean time of sun's visible setting.]

Lat. S.	Approx. date.	SEPTEMBER.			OCTOBER.												NOVEMBER.							DECEMBER.			Approx. date.	Lat. S.
		22	26	28	1	4	6	9	11	14	17	19	22	25	28	31	3	6	10	14	17	22	27	8	11	22		
	Dec. S.	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	13°	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	23° 27′	Dec. S.	
°		h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.		°
41	R.	5 47	5 43	5 39	5 35	5 31	5 26	5 22	5 17	5 13	5 09	5 05	5 01	4 56	4 52	4 48	4 45	4 41	4 37	4 33	4 30	4 27	4 24	4 22	4 21	4 24	R.	41
	S.	5 57	6 00	6 03	6 05	6 08	6 11	6 14	6 16	6 19	6 22	6 26	6 29	6 32	6 35	6 39	6 43	6 47	6 51	6 55	7 00	7 06	7 11	7 18	7 25	7 33	S.	
42	R.	5 47	5 43	5 39	5 34	5 30	5 25	5 21	5 17	5 12	5 08	5 04	4 59	4 55	4 50	4 46	4 43	4 39	4 35	4 31	4 28	4 24	4 21	4 19	4 18	4 20	R.	42
	S.	5 57	6 00	6 03	6 05	6 08	6 11	6 14	6 17	6 20	6 23	6 27	6 30	6 34	6 37	6 41	6 45	6 49	6 53	6 58	7 03	7 08	7 14	7 21	7 28	7 36	S.	
43	R.	5 47	5 42	5 38	5 34	5 29	5 25	5 20	5 16	5 11	5 07	5 02	4 58	4 53	4 49	4 44	4 40	4 36	4 32	4 28	4 25	4 21	4 18	4 15	4 14	4 17	R.	43
	S.	5 57	6 00	6 03	6 06	6 09	6 12	6 15	6 18	6 21	6 25	6 28	6 32	6 35	6 39	6 43	6 47	6 51	6 55	7 00	7 06	7 11	7 17	7 24	7 32	7 40	S.	
44	R.	5 47	5 42	5 38	5 33	5 29	5 24	5 19	5 15	5 10	5 06	5 01	4 56	4 52	4 47	4 42	4 38	4 34	4 29	4 25	4 22	4 18	4 15	4 12	4 10	4 13	R.	44
	S.	5 58	6 01	6 04	6 07	6 10	6 13	6 16	6 19	6 22	6 26	6 30	6 33	6 37	6 41	6 45	6 49	6 54	6 58	7 03	7 09	7 15	7 21	7 28	7 36	7 44	S.	
45	R.	5 47	5 42	5 37	5 33	5 28	5 23	5 18	5 13	5 09	5 04	4 59	4 55	4 50	4 45	4 40	4 36	4 31	4 27	4 22	4 18	4 15	4 11	4 08	4 06	4 09	R.	45
	S.	5 58	6 01	6 04	6 07	6 11	6 14	6 17	6 20	6 24	6 27	6 31	6 35	6 39	6 43	6 47	6 52	6 56	7 01	7 06	7 12	7 18	7 25	7 32	7 40	7 48	S.	
46	R.	5 47	5 42	5 37	5 32	5 27	5 22	5 17	5 12	5 08	5 03	4 58	4 53	4 48	4 43	4 38	4 34	4 29	4 24	4 19	4 15	4 11	4 07	4 04	4 02	4 05	R.	46
	S.	5 58	6 01	6 04	6 07	6 11	6 14	6 18	6 21	6 25	6 29	6 33	6 36	6 40	6 45	6 49	6 54	6 59	7 04	7 09	7 15	7 21	7 28	7 36	7 44	7 52	S.	
47	R.	5 47	5 42	5 37	5 32	5 27	5 21	5 16	5 11	5 06	5 01	4 56	4 51	4 46	4 41	4 36	4 31	4 26	4 21	4 16	4 12	4 08	4 04	4 00	3 58	4 00	R.	47
	S.	5 58	6 01	6 05	6 08	6 12	6 15	6 19	6 22	6 26	6 30	6 34	6 38	6 42	6 47	6 52	6 56	7 01	7 06	7 12	7 18	7 25	7 32	7 40	7 48	7 56	S.	
48	R.	5 47	5 41	5 36	5 31	5 26	5 21	5 15	5 10	5 05	5 00	4 54	4 49	4 44	4 39	4 33	4 28	4 23	4 18	4 13	4 09	4 04	4 00	3 56	3 54	3 56	R.	48
	S.	5 58	6 01	6 05	6 08	6 12	6 16	6 20	6 24	6 28	6 32	6 36	6 40	6 44	6 49	6 54	6 59	7 04	7 09	7 15	7 22	7 28	7 35	7 44	7 53	8 01	S.	
49	R.	5 47	5 41	5 36	5 30	5 25	5 20	5 14	5 09	5 03	4 58	4 52	4 47	4 42	4 36	4 31	4 26	4 20	4 15	4 10	4 05	4 01	3 56	3 52	3 49	3 51	R.	49
	S.	5 58	6 02	6 06	6 09	6 13	6 17	6 21	6 25	6 29	6 34	6 38	6 42	6 47	6 52	6 57	7 02	7 07	7 13	7 19	7 25	7 32	7 39	7 48	7 57	8 06	S.	
50	R.	5 46	5 41	5 36	5 30	5 25	5 19	5 13	5 07	5 02	4 56	4 51	4 45	4 40	4 34	4 28	4 23	4 17	4 12	4 07	4 02	3 57	3 52	3 47	3 44	3 46	R.	50
	S.	5 58	6 02	6 06	6 10	6 14	6 18	6 22	6 26	6 31	6 35	6 40	6 44	6 49	6 54	6 59	7 05	7 10	7 16	7 22	7 29	7 36	7 44	7 52	8 02	8 10	S.	
51	R.	5 46	5 41	5 35	5 29	5 24	5 18	5 12	5 06	5 00	4 55	4 49	4 43	4 37	4 31	4 26	4 20	4 14	4 08	4 03	3 58	3 52	3 47	3 43	3 39	3 41	R.	51
	S.	5 58	6 02	6 06	6 10	6 15	6 19	6 24	6 28	6 32	6 37	6 42	6 46	6 51	6 56	7 02	7 08	7 13	7 19	7 26	7 33	7 40	7 48	7 57	8 07	8 16	S.	
52	R.	5 46	5 40	5 35	5 29	5 23	5 17	5 11	5 04	4 59	4 53	4 47	4 41	4 35	4 29	4 23	4 17	4 11	4 06	3 59	3 53	3 48	3 42	3 37	3 34	3 35	R.	52
	S.	5 58	6 02	6 07	6 11	6 16	6 20	6 25	6 29	6 34	6 39	6 44	6 49	6 54	6 59	7 05	7 11	7 17	7 23	7 30	7 37	7 45	7 53	8 02	8 13	8 21	S.	
53	R.	5 46	5 40	5 34	5 28	5 22	5 16	5 09	5 03	4 57	4 51	4 45	4 39	4 32	4 26	4 20	4 14	4 07	4 01	3 55	3 49	3 43	3 37	3 32	3 28	3 29	R.	53
	S.	5 58	6 03	6 07	6 12	6 17	6 21	6 26	6 31	6 36	6 41	6 46	6 51	6 56	7 02	7 08	7 14	7 20	7 27	7 34	7 42	7 50	7 58	8 08	8 19	8 27	S.	
54	R.	5 46	5 40	5 34	5 27	5 21	5 14	5 08	5 01	4 55	4 49	4 43	4 36	4 30	4 23	4 17	4 10	4 04	3 57	3 50	3 44	3 38	3 32	3 26	3 22	3 23	R.	54
	S.	5 59	6 03	6 08	6 12	6 18	6 22	6 27	6 32	6 37	6 43	6 48	6 53	6 59	7 05	7 11	7 17	7 24	7 31	7 38	7 46	7 55	8 04	8 14	8 25	8 34	S.	
55	R.	5 46	5 39	5 33	5 26	5 20	5 13	5 07	5 00	4 53	4 47	4 40	4 34	4 27	4 20	4 13	4 07	4 00	3 53	3 46	3 39	3 33	3 26	3 20	3 15	3 16	R.	55
	S.	5 59	6 03	6 08	6 13	6 18	6 23	6 29	6 34	6 39	6 45	6 50	6 56	7 02	7 08	7 14	7 21	7 28	7 35	7 43	7 51	8 00	8 09	8 20	8 32	8 41	S.	
56	R.	5 45	5 39	5 33	5 26	5 19	5 12	5 05	4 58	4 51	4 45	4 38	4 31	4 24	4 17	4 10	4 03	3 55	3 48	3 41	3 34	3 27	3 20	3 13	3 08	3 08	R.	56
	S.	5 59	6 04	6 09	6 14	6 20	6 25	6 30	6 35	6 41	6 47	6 53	6 59	7 05	7 11	7 18	7 25	7 32	7 40	7 48	7 56	8 05	8 15	8 26	8 39	8 48	S.	
57	R.	5 45	5 38	5 32	5 25	5 18	5 11	5 04	4 56	4 49	4 42	4 35	4 28	4 20	4 13	4 06	3 58	3 51	3 43	3 36	3 28	3 21	3 13	3 06	3 00	3 00	R.	57
	S.	5 59	6 04	6 10	6 15	6 21	6 26	6 32	6 37	6 43	6 49	6 56	7 02	7 08	7 15	7 22	7 29	7 37	7 45	7 53	8 02	8 12	8 22	8 33	8 46	8 56	S.	
58	R.	5 45	5 38	5 31	5 24	5 17	5 09	5 02	4 54	4 47	4 40	4 32	4 25	4 17	4 09	4 02	3 54	3 46	3 38	3 30	3 22	3 14	3 06	2 58	2 51	2 51	R.	58
	S.	5 59	6 05	6 10	6 16	6 22	6 27	6 33	6 39	6 45	6 52	6 58	7 05	7 12	7 19	7 26	7 34	7 42	7 50	7 59	8 08	8 18	8 29	8 41	8 55	9 06	S.	
59	R.	5 45	5 37	5 30	5 23	5 15	5 08	5 00	4 52	4 45	4 37	4 29	4 21	4 13	4 05	3 57	3 49	3 41	3 32	3 24	3 16	3 07	2 58	2 50	2 42	2 42	R.	59
	S.	6 00	6 05	6 11	6 17	6 23	6 29	6 35	6 41	6 48	6 54	7 01	7 08	7 15	7 23	7 31	7 39	7 47	7 55	8 04	8 14	8 25	8 37	8 50	9 04	9 15	S.	
60	R.	5 45	5 37	5 30	5 22	5 14	5 06	4 58	4 50	4 43	4 35	4 27	4 18	4 10	4 01	3 53	3 44	3 35	3 27	3 18	3 09	3 00	2 51	2 41	2 31	2 31	R.	60
	S.	6 00	6 06	6 12	6 18	6 24	6 30	6 37	6 43	6 50	6 57	7 04	7 11	7 19	7 27	7 35	7 43	7 52	8 01	8 11	8 22	8 33	8 45	8 59	9 15	9 26	S.	

TABLE 10.

Mean Time of Sun's Visible Rising and Setting.

South Latitude: 0° to 20°—December 22 to March 21.

[R=Local mean time of sun's visible rising. S=Local mean time of sun's visible setting.]

Lat. S.	Approx. date	DECEMBER.	JANUARY.						FEBRUARY.									MARCH.									Approx. date	Lat. S.
		22	2	10	16	21	25	29	2	5	9	12	15	18	20	23	26	1	3	6	8	11	13	16	18	21		
	Dec. S.	23° 27′	23°	22°	21°	20°	19°	18°	17°	16°	15°	14°	13°	12°	11°	10°	9°	8°	7°	6°	5°	4°	3°	2°	1°	0°	Dec. S.	
°		h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.		°
0	R.	5 54	6 00	6 04	6 06	6 07	6 08	6 09	6 10	6 10	6 10	6 10	6 10	6 10	6 10	6 10	6 09	6 09	6 08	6 08	6 07	6 06	6 06	6 05	6 04	6 04	R.	0
	S.	6 02	6 08	6 12	6 14	6 15	6 16	6 17	6 18	6 18	6 18	6 18	6 18	6 18	6 18	6 18	6 17	6 17	6 16	6 16	6 15	6 14	6 14	6 13	6 12	6 11	S.	
1	R.	5 53	5 58	6 02	6 04	6 06	6 07	6 08	6 09	6 09	6 09	6 09	6 10	6 10	6 09	6 09	6 09	6 08	6 08	6 08	6 07	6 06	6 06	6 05	6 04	6 04	R.	1
	S.	6 04	6 09	6 13	6 15	6 17	6 17	6 18	6 19	6 19	6 19	6 19	6 19	6 19	6 18	6 18	6 18	6 17	6 16	6 16	6 15	6 14	6 14	6 13	6 12	6 11	S.	
2	R.	5 51	5 57	6 01	6 03	6 04	6 06	6 07	6 08	6 08	6 08	6 08	6 09	6 09	6 09	6 09	6 08	6 08	6 08	6 08	6 07	6 06	6 06	6 05	6 04	6 04	R.	2
	S.	6 05	6 11	6 15	6 17	6 18	6 19	6 19	6 20	6 20	6 20	6 20	6 20	6 19	6 19	6 19	6 18	6 17	6 17	6 16	6 15	6 14	6 14	6 13	6 12	6 11	S.	
3	R.	5 49	5 55	5 59	6 01	6 03	6 04	6 06	6 07	6 07	6 07	6 07	6 08	6 08	6 08	6 08	6 08	6 08	6 07	6 07	6 07	6 06	6 06	6 05	6 04	6 04	R.	3
	S.	6 07	6 13	6 16	6 18	6 20	6 20	6 21	6 21	6 21	6 21	6 21	6 21	6 20	6 20	6 20	6 19	6 18	6 17	6 16	6 16	6 15	6 14	6 13	6 12	6 11	S.	
4	R.	5 48	5 53	5 57	6 00	6 01	6 03	6 04	6 06	6 06	6 06	6 06	6 07	6 07	6 07	6 07	6 07	6 07	6 07	6 07	6 07	6 06	6 06	6 05	6 04	6 04	R.	4
	S.	6 09	6 14	6 18	6 20	6 21	6 22	6 22	6 22	6 22	6 22	6 22	6 22	6 21	6 20	6 20	6 19	6 18	6 18	6 17	6 16	6 15	6 14	6 13	6 12	6 11	S.	
5	R.	5 46	5 52	5 56	5 58	6 00	6 01	6 03	6 04	6 05	6 05	6 05	6 06	6 06	6 06	6 06	6 06	6 06	6 06	6 06	6 06	6 05	6 05	6 04	6 04	6 04	R.	5
	S.	6 11	6 16	6 20	6 21	6 23	6 23	6 24	6 24	6 24	6 23	6 23	6 23	6 22	6 21	6 21	6 20	6 19	6 18	6 17	6 16	6 15	6 14	6 13	6 12	6 11	S.	
6	R.	5 44	5 50	5 54	5 57	5 58	6 00	6 02	6 03	6 04	6 04	6 04	6 05	6 06	6 06	6 06	6 06	6 06	6 06	6 06	6 06	6 05	6 05	6 04	6 04	6 03	R.	6
	S.	6 12	6 17	6 21	6 23	6 24	6 24	6 25	6 25	6 25	6 24	6 24	6 23	6 23	6 22	6 22	6 21	6 20	6 19	6 18	6 17	6 15	6 14	6 13	6 12	6 11	S.	
7	R.	5 42	5 48	5 52	5 55	5 57	5 59	6 00	6 01	6 02	6 03	6 03	6 04	6 05	6 05	6 05	6 05	6 05	6 05	6 05	6 05	6 05	6 05	6 04	6 04	6 03	R.	7
	S.	6 14	6 19	6 23	6 25	6 26	6 26	6 26	6 26	6 26	6 26	6 25	6 24	6 24	6 23	6 22	6 21	6 20	6 19	6 18	6 17	6 16	6 15	6 13	6 12	6 11	S.	
8	R.	5 41	5 46	5 50	5 53	5 55	5 57	5 59	6 00	6 01	6 02	6 02	6 03	6 04	6 04	6 04	6 04	6 05	6 05	6 05	6 05	6 04	6 05	6 04	6 04	6 03	R.	8
	S.	6 16	6 21	6 25	6 26	6 27	6 27	6 28	6 27	6 27	6 27	6 26	6 25	6 25	6 24	6 23	6 22	6 21	6 20	6 19	6 18	6 16	6 15	6 13	6 12	6 11	S.	
9	R.	5 39	5 45	5 49	5 52	5 54	5 56	5 57	5 59	6 00	6 01	6 01	6 02	6 03	6 03	6 03	6 04	6 04	6 04	6 04	6 04	6 04	6 04	6 04	6 04	6 03	R.	9
	S.	6 18	6 23	6 27	6 28	6 29	6 29	6 29	6 29	6 29	6 28	6 27	6 26	6 26	6 25	6 24	6 23	6 22	6 20	6 19	6 18	6 17	6 15	6 14	6 13	6 11	S.	
10	R.	5 37	5 43	5 47	5 50	5 52	5 54	5 56	5 58	5 59	6 00	6 00	6 01	6 02	6 02	6 02	6 03	6 03	6 04	6 04	6 04	6 04	6 04	6 04	6 04	6 03	R.	10
	S.	6 19	6 25	6 28	6 29	6 30	6 30	6 30	6 30	6 30	6 29	6 28	6 27	6 26	6 25	6 24	6 23	6 22	6 21	6 20	6 18	6 17	6 15	6 14	6 13	6 11	S.	
11	R.	5 35	5 41	5 46	5 49	5 51	5 53	5 55	5 56	5 58	5 59	5 59	6 00	6 01	6 01	6 02	6 02	6 03	6 03	6 03	6 04	6 04	6 04	6 04	6 04	6 03	R.	11
	S.	6 21	6 27	6 30	6 31	6 32	6 32	6 32	6 31	6 31	6 30	6 29	6 28	6 27	6 26	6 25	6 24	6 23	6 21	6 20	6 19	6 17	6 16	6 14	6 13	6 11	S.	
12	R.	5 33	5 39	5 44	5 47	5 49	5 52	5 54	5 55	5 57	5 58	5 58	5 59	6 00	6 01	6 01	6 02	6 02	6 03	6 03	6 03	6 03	6 04	6 04	6 04	6 03	R.	12
	S.	6 23	6 28	6 31	6 32	6 33	6 33	6 33	6 32	6 32	6 31	6 30	6 29	6 28	6 27	6 26	6 25	6 23	6 22	6 21	6 19	6 17	6 16	6 14	6 13	6 11	S.	
13	R.	5 31	5 37	5 42	5 46	5 48	5 50	5 52	5 54	5 55	5 56	5 57	5 58	5 59	6 00	6 00	6 01	6 01	6 02	6 02	6 03	6 03	6 03	6 03	6 03	6 03	R.	13
	S.	6 25	6 30	6 33	6 34	6 35	6 34	6 34	6 34	6 33	6 32	6 31	6 30	6 29	6 28	6 27	6 26	6 24	6 23	6 21	6 20	6 18	6 16	6 14	6 13	6 11	S.	
14	R.	5 29	5 35	5 41	5 44	5 46	5 49	5 51	5 53	5 54	5 55	5 56	5 57	5 58	5 59	6 00	6 00	6 01	6 01	6 02	6 03	6 03	6 03	6 03	6 03	6 03	R.	14
	S.	6 27	6 32	6 35	6 36	6 36	6 36	6 36	6 35	6 34	6 33	6 32	6 31	6 30	6 29	6 28	6 26	6 25	6 23	6 22	6 20	6 18	6 16	6 14	6 13	6 11	S.	
15	R.	5 27	5 33	5 39	5 42	5 45	5 47	5 49	5 51	5 53	5 54	5 55	5 56	5 57	5 58	5 59	6 00	6 00	6 01	6 01	6 02	6 02	6 03	6 03	6 03	6 03	R.	15
	S.	6 29	6 34	6 37	6 37	6 38	6 37	6 37	6 36	6 35	6 34	6 33	6 32	6 31	6 30	6 28	6 27	6 25	6 24	6 22	6 20	6 18	6 17	6 15	6 13	6 11	S.	
16	R.	5 25	5 32	5 37	5 41	5 43	5 46	5 48	5 50	5 52	5 53	5 54	5 55	5 56	5 57	5 58	5 59	6 00	6 00	6 01	6 02	6 02	6 03	6 03	6 03	6 03	R.	16
	S.	6 31	6 36	6 38	6 39	6 39	6 39	6 39	6 38	6 37	6 35	6 34	6 33	6 32	6 30	6 29	6 27	6 26	6 24	6 23	6 21	6 19	6 17	6 15	6 13	6 11	S.	
17	R.	5 23	5 30	5 35	5 39	5 41	5 44	5 46	5 48	5 50	5 52	5 53	5 54	5 55	5 56	5 57	5 58	5 59	6 00	6 00	6 01	6 01	6 02	6 03	6 03	6 03	R.	17
	S.	6 33	6 38	6 40	6 41	6 41	6 41	6 40	6 39	6 38	6 37	6 36	6 34	6 33	6 31	6 30	6 28	6 27	6 25	6 23	6 21	6 19	6 17	6 15	6 13	6 11	S.	
18	R.	5 21	5 28	5 34	5 37	5 40	5 42	5 45	5 47	5 49	5 51	5 52	5 53	5 54	5 55	5 56	5 57	5 58	5 59	6 00	6 01	6 01	6 02	6 03	6 03	6 03	R.	18
	S.	6 35	6 39	6 42	6 42	6 43	6 42	6 41	6 40	6 39	6 38	6 37	6 35	6 34	6 32	6 31	6 29	6 27	6 25	6 23	6 21	6 19	6 17	6 15	6 13	6 11	S.	
19	R.	5 19	5 26	5 32	5 35	5 38	5 41	5 44	5 46	5 48	5 49	5 51	5 52	5 53	5 54	5 55	5 57	5 58	5 59	6 00	6 01	6 01	6 02	6 02	6 03	6 03	R.	19
	S.	6 37	6 41	6 44	6 44	6 44	6 44	6 43	6 42	6 41	6 39	6 38	6 36	6 35	6 33	6 31	6 30	6 28	6 26	6 24	6 22	6 20	6 18	6 15	6 13	6 11	S.	
20	R.	5 17	5 24	5 30	5 34	5 37	5 39	5 42	5 44	5 46	5 48	5 50	5 51	5 52	5 54	5 55	5 56	5 57	5 58	5 59	6 00	6 01	6 02	6 02	6 03	6 03	R.	20
	S.	6 39	6 43	6 46	6 46	6 46	6 45	6 44	6 43	6 42	6 40	6 39	6 37	6 36	6 34	6 32	6 30	6 28	6 26	6 24	6 22	6 20	6 18	6 15	6 13	6 11	S.	

TABLE 10.

Mean Time of Sun's Visible Rising and Setting.

South Latitude: 21° to 40°—December 22 to March 21.

[R=Local mean time of sun's visible rising. S=Local mean time of sun's visible setting.]

Lat. S.	Approx. date.	DECEMBER.	JANUARY.						FEBRUARY.									MARCH.									Approx. date.	Lat. S.
		22	2	10	16	21	25	29	2	5	9	12	15	18	20	23	26	1	3	6	8	11	13	16	18	21		
	Dec. S.	23° 27′	23°	22°	21°	20°	19°	18°	17°	16°	15°	14°	13°	12°	11°	10°	9°	8°	7°	6°	5°	4°	3°	2°	1°	0°	Dec. S.	
°		h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.		°
21	R.	5 15	5 22	5 28	5 32	5 35	5 38	5 41	5 43	5 45	5 47	5 48	5 50	5 51	5 53	5 54	5 55	5 56	5 58	5 59	6 00	6 00	6 01	6 02	6 03	6 03	R.	21
	S.	6 41	6 46	6 48	6 48	6 48	6 47	6 46	6 45	6 44	6 42	6 40	6 39	6 37	6 35	6 33	6 31	6 29	6 27	6 25	6 23	6 20	6 18	6 16	6 14	6 11	S.	
22	R.	5 13	5 20	5 26	5 30	5 33	5 36	5 39	5 41	5 44	5 46	5 47	5 49	5 50	5 52	5 53	5 54	5 56	5 57	5 58	6 00	6 00	6 01	6 02	6 03	6 03	R.	22
	S.	6 43	6 48	6 50	6 50	6 49	6 48	6 47	6 46	6 45	6 43	6 41	6 40	6 38	6 36	6 34	6 32	6 30	6 27	6 25	6 23	6 20	6 18	6 16	6 14	6 11	S.	
23	R.	5 11	5 18	5 24	5 28	5 31	5 34	5 37	5 40	5 42	5 44	5 46	5 48	5 49	5 51	5 53	5 54	5 55	5 57	5 58	5 59	6 00	6 01	6 02	6 03	6 03	R.	23
	S.	6 45	6 50	6 52	6 52	6 51	6 50	6 49	6 48	6 46	6 44	6 43	6 41	6 39	6 37	6 35	6 33	6 30	6 28	6 26	6 23	6 21	6 19	6 16	6 14	6 11	S.	
24	R.	5 09	5 16	5 22	5 26	5 30	5 33	5 36	5 38	5 41	5 43	5 45	5 47	5 48	5 50	5 52	5 53	5 55	5 56	5 57	5 59	6 00	6 01	6 02	6 03	6 03	R.	24
	S.	6 47	6 52	6 54	6 53	6 53	6 52	6 51	6 49	6 48	6 46	6 44	6 42	6 40	6 38	6 36	6 33	6 31	6 28	6 26	6 24	6 21	6 19	6 16	6 14	6 11	S.	
25	R.	5 07	5 14	5 20	5 24	5 28	5 31	5 34	5 37	5 39	5 41	5 43	5 46	5 47	5 49	5 51	5 52	5 54	5 55	5 57	5 58	5 59	6 00	6 01	6 02	6 03	R.	25
	S.	6 50	6 54	6 56	6 55	6 55	6 54	6 53	6 51	6 49	6 47	6 45	6 43	6 41	6 39	6 37	6 34	6 32	6 29	6 27	6 24	6 21	6 19	6 16	6 14	6 11	S.	
26	R.	5 05	5 12	5 18	5 22	5 26	5 29	5 32	5 35	5 38	5 40	5 42	5 44	5 46	5 48	5 50	5 51	5 53	5 55	5 56	5 58	5 59	6 00	6 01	6 02	6 03	R.	26
	S.	6 52	6 56	6 58	6 57	6 56	6 55	6 54	6 52	6 51	6 48	6 46	6 44	6 42	6 40	6 38	6 35	6 32	6 30	6 27	6 25	6 22	6 19	6 16	6 14	6 11	S.	
27	R.	5 02	5 09	5 16	5 20	5 24	5 28	5 31	5 34	5 36	5 39	5 41	5 43	5 45	5 47	5 49	5 50	5 52	5 54	5 56	5 57	5 58	6 00	6 01	6 02	6 03	R.	27
	S.	6 54	6 58	7 00	6 59	6 58	6 57	6 56	6 54	6 52	6 50	6 48	6 45	6 43	6 41	6 39	6 36	6 33	6 30	6 28	6 25	6 22	6 20	6 17	6 14	6 11	S.	
28	R.	5 00	5 07	5 14	5 18	5 22	5 26	5 29	5 32	5 35	5 37	5 39	5 42	5 44	5 46	5 48	5 49	5 51	5 53	5 55	5 57	5 58	5 59	6 00	6 02	6 03	R.	28
	S.	6 56	7 00	7 02	7 01	7 00	6 59	6 57	6 55	6 53	6 51	6 49	6 47	6 44	6 42	6 40	6 37	6 34	6 31	6 28	6 26	6 23	6 20	6 17	6 14	6 11	S.	
29	R.	4 58	5 05	5 11	5 16	5 20	5 24	5 27	5 30	5 33	5 36	5 38	5 40	5 43	5 45	5 47	5 48	5 50	5 52	5 54	5 56	5 58	5 59	6 00	6 02	6 03	R.	29
	S.	6 59	7 03	7 04	7 03	7 02	7 01	6 59	6 57	6 55	6 53	6 51	6 48	6 46	6 43	6 41	6 38	6 35	6 32	6 29	6 26	6 23	6 20	6 17	6 14	6 11	S.	
30	R.	4 55	5 02	5 09	5 14	5 18	5 22	5 26	5 29	5 32	5 34	5 37	5 39	5 42	5 44	5 46	5 48	5 50	5 52	5 54	5 56	5 57	5 59	6 00	6 02	6 03	R.	30
	S.	7 01	7 05	7 06	7 05	7 04	7 02	7 01	6 59	6 57	6 54	6 52	6 49	6 47	6 44	6 42	6 39	6 36	6 33	6 30	6 27	6 23	6 21	6 18	6 15	6 12	S.	
31	R.	4 53	5 00	5 07	5 12	5 16	5 20	5 24	5 27	5 30	5 33	5 35	5 38	5 40	5 42	5 45	5 47	5 49	5 51	5 53	5 55	5 57	5 58	6 00	6 02	6 03	R.	31
	S.	7 04	7 08	7 09	7 08	7 06	7 04	7 03	7 01	6 58	6 56	6 53	6 51	6 48	6 45	6 43	6 40	6 37	6 33	6 30	6 27	6 24	6 21	6 18	6 15	6 12	S.	
32	R.	4 50	4 57	5 04	5 10	5 14	5 18	5 22	5 25	5 28	5 31	5 34	5 37	5 39	5 41	5 44	5 46	5 48	5 51	5 53	5 55	5 56	5 58	5 59	6 01	6 03	R.	32
	S.	7 06	7 10	7 11	7 10	7 08	7 06	7 05	7 03	7 00	6 57	6 55	6 52	6 49	6 46	6 44	6 41	6 37	6 34	6 31	6 28	6 24	6 21	6 18	6 15	6 12	S.	
33	R.	4 48	4 55	5 02	5 07	5 12	5 16	5 20	5 23	5 27	5 30	5 32	5 35	5 38	5 40	5 54	5 45	5 47	5 50	5 52	5 54	5 56	5 58	5 59	6 01	6 03	R.	33
	S.	7 09	7 13	7 14	7 12	7 11	7 09	7 07	7 04	7 02	6 59	6 56	6 53	6 50	6 47	6 45	6 42	6 38	6 35	6 32	6 29	6 25	6 22	6 18	6 15	6 12	S.	
34	R.	4 45	4 52	4 59	5 05	5 10	5 14	5 18	5 21	5 25	5 28	5 31	5 34	5 37	5 39	5 42	5 44	5 47	5 49	5 51	5 53	5 55	5 57	5 59	6 01	6 03	R.	34
	S.	7 11	7 15	7 16	7 15	7 13	7 11	7 09	7 06	7 03	7 00	6 58	6 55	6 52	6 49	6 46	6 43	6 39	6 35	6 32	6 29	6 25	6 22	6 18	6 15	6 12	S.	
35	R.	4 42	4 50	4 57	5 02	5 07	5 12	5 16	5 19	5 23	5 26	5 29	5 32	5 35	5 38	5 41	5 43	5 46	5 48	5 50	5 53	5 55	5 57	5 59	6 01	6 03	R.	35
	S.	7 14	7 18	7 19	7 17	7 15	7 13	7 11	7 08	7 05	7 02	6 59	6 56	6 53	6 50	6 47	6 44	6 40	6 36	6 33	6 30	6 26	6 23	6 19	6 15	6 12	S.	
36	R.	4 39	4 47	4 54	5 00	5 05	5 09	5 14	5 17	5 21	5 25	5 28	5 31	5 34	5 37	5 40	5 42	5 45	5 47	5 50	5 52	5 54	5 57	5 59	6 01	6 03	R.	36
	S.	7 17	7 21	7 21	7 20	7 18	7 15	7 13	7 10	7 07	7 04	7 01	6 58	6 55	6 51	6 48	6 45	6 41	6 37	6 34	6 30	6 26	6 23	6 19	6 15	6 12	S.	
37	R.	4 36	4 44	4 52	4 57	5 02	5 07	5 11	5 15	5 19	5 23	5 26	5 29	5 32	5 35	5 38	5 41	5 44	5 46	5 49	5 51	5 54	5 56	5 58	6 01	6 03	R.	37
	S.	7 20	7 24	7 24	7 22	7 20	7 18	7 15	7 12	7 09	7 06	7 03	6 59	6 56	6 52	6 49	6 46	6 42	6 38	6 35	6 31	6 27	6 23	6 19	6 16	6 12	S.	
38	R.	4 33	4 41	4 49	4 55	5 00	5 05	5 09	5 13	5 17	5 21	5 24	5 28	5 31	5 34	5 37	5 40	5 43	5 46	5 48	5 51	5 53	5 56	5 58	6 00	6 02	R.	38
	S.	7 23	7 27	7 27	7 25	7 23	7 20	7 17	7 14	7 11	7 08	7 04	7 01	6 58	6 54	6 50	6 47	6 43	6 39	6 35	6 32	6 28	6 24	6 20	6 16	6 12	S.	
39	R.	4 30	4 38	4 46	4 52	4 57	5 02	5 07	5 11	5 15	5 19	5 22	5 26	5 29	5 32	5 36	5 39	5 42	5 45	5 47	5 50	5 52	5 55	5 58	6 00	6 02	R.	39
	S.	7 26	7 30	7 30	7 28	7 25	7 22	7 19	7 16	7 13	7 10	7 06	7 03	6 59	6 55	6 52	6 48	6 44	6 40	6 36	6 32	6 28	6 24	6 20	6 16	6 12	S.	
40	R.	4 27	4 35	4 43	4 49	4 55	5 00	5 05	5 09	5 13	5 17	5 21	5 24	5 28	5 31	5 35	5 38	5 41	5 44	5 47	5 50	5 52	5 55	5 57	6 00	6 02	R.	40
	S.	7 29	7 33	7 33	7 30	7 28	7 25	7 22	7 18	7 15	7 11	7 08	7 04	7 01	6 57	6 53	6 49	6 45	6 41	6 37	6 33	6 28	6 25	6 20	6 16	6 12	S.	

TABLE 10.

Mean Time of Sun's Visible Rising and Setting.

South Latitude: 41° to 60°—December 22 to March 21.

[R=Local mean time of sun's visible rising. S=Local mean time of sun's visible setting.]

Lat. S.	Approx. date.	DECEMBER.	JANUARY.						FEBRUARY.									MARCH.									Approx. date.	Lat. S.
		22	2	10	16	21	25	29	2	5	9	12	15	18	20	23	26	1	3	6	8	11	13	16	18	21		
	Dec. S.	23° 27′	23°	22°	21°	20°	19°	18°	17°	16°	15°	14°	13°	12°	11°	10°	9°	8°	7°	6°	5°	4°	3°	2°	1°	0°	Dec. S.	
°		h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.		°
41	R.	4 24	4 32	4 40	4 46	4 52	4 57	5 02	5 07	5 11	5 15	5 19	5 23	5 26	5 30	5 33	5 37	5 40	5 43	5 46	5 49	5 52	5 55	5 57	6 00	6 02	R.	41
	S.	7 33	7 36	7 36	7 33	7 31	7 27	7 24	7 21	7 17	7 13	7 10	7 06	7 02	6 58	6 54	6 50	6 46	6 42	6 38	6 34	6 29	6 25	6 21	6 17	6 12	S.	
42	R.	4 20	4 29	4 37	4 43	4 49	4 55	5 00	5 05	5 09	5 13	5 17	5 21	5 25	5 28	5 32	5 36	5 39	5 42	5 45	5 48	5 51	5 54	5 57	6 00	6 02	R.	42
	S.	7 36	7 39	7 39	7 36	7 33	7 30	7 27	7 23	7 19	7 15	7 12	7 08	7 04	6 59	6 55	6 51	6 47	6 42	6 38	6 34	6 29	6 25	6 21	6 17	6 12	S.	
43	R.	4 17	4 25	4 33	4 40	4 46	4 52	4 57	5 02	5 07	5 11	5 15	5 19	5 23	5 27	5 31	5 34	5 38	5 41	5 44	5 48	5 51	5 54	5 56	5 59	6 02	R.	43
	S.	7 40	7 43	7 42	7 39	7 36	7 33	7 29	7 25	7 22	7 18	7 14	7 09	7 05	7 01	6 57	6 52	6 48	6 43	6 39	6 35	6 30	6 26	6 21	6 17	6 12	S.	
44	R.	4 13	4 21	4 29	4 37	4 43	4 49	4 54	4 59	5 04	5 09	5 13	5 17	5 21	5 25	5 29	5 33	5 37	5 40	5 43	5 47	5 50	5 53	5 56	5 59	6 02	R.	44
	S.	7 44	7 47	7 46	7 43	7 39	7 36	7 32	7 28	7 24	7 20	7 16	7 11	7 07	7 02	6 58	6 53	6 49	6 44	6 40	6 36	6 31	6 26	6 22	6 17	6 13	S.	
45	R.	4 09	4 17	4 26	4 33	4 40	4 46	4 51	4 57	5 02	5 06	5 11	5 15	5 20	5 24	5 28	5 32	5 35	5 39	5 42	5 46	5 49	5 53	5 56	5 59	6 02	R.	45
	S.	7 48	7 51	7 50	7 46	7 43	7 39	7 35	7 31	7 27	7 22	7 18	7 13	7 09	7 04	7 00	6 55	6 50	6 46	6 41	6 37	6 32	6 27	6 22	6 18	6 13	S.	
46	R.	4 05	4 13	4 22	4 29	4 36	4 42	4 48	4 54	4 59	5 04	5 09	5 13	5 18	5 22	5 26	5 30	5 34	5 38	5 41	5 45	5 48	5 52	5 55	5 59	6 02	R.	46
	S.	7 52	7 55	7 54	7 50	7 46	7 42	7 38	7 34	7 29	7 24	7 20	7 15	7 10	7 05	7 01	6 56	6 51	6 47	6 42	6 37	6 32	6 27	6 22	6 18	6 13	S.	
47	R.	4 00	4 09	4 18	4 26	4 33	4 39	4 45	4 51	4 57	5 02	5 06	5 11	5 16	5 20	5 24	5 29	5 33	5 37	5 40	5 44	5 48	5 52	5 55	5 59	6 02	R.	47
	S.	7 56	7 59	7 57	7 54	7 50	7 45	7 41	7 36	7 32	7 27	7 22	7 17	7 12	7 07	7 03	6 58	6 53	6 48	6 43	6 38	6 33	6 28	6 23	6 18	6 13	S.	
48	R.	3 56	4 04	4 14	4 22	4 29	4 36	4 42	4 48	4 54	4 59	5 04	5 09	5 14	5 18	5 23	5 27	5 31	5 35	5 39	5 43	5 47	5 51	5 54	5 58	6 02	R.	48
	S.	8 01	8 03	8 01	7 57	7 53	7 49	7 44	7 39	7 35	7 30	7 25	7 19	7 14	7 09	7 05	6 59	6 54	6 49	6 44	6 39	6 33	6 28	6 23	6 18	6 13	S.	
49	R.	3 51	4 00	4 10	4 18	4 26	4 32	4 39	4 45	4 51	4 56	5 01	5 07	5 12	5 16	5 21	5 25	5 30	5 34	5 38	5 42	5 46	5 50	5 54	5 58	6 01	R.	49
	S.	8 05	8 08	8 06	8 01	7 57	7 52	7 48	7 43	7 38	7 32	7 27	7 22	7 17	7 11	7 06	7 01	6 56	6 50	6 45	6 40	6 34	6 29	6 24	6 19	6 13	S.	
50	R.	3 46	3 55	4 05	4 14	4 22	4 29	4 35	4 42	4 48	4 53	4 59	5 04	5 09	5 14	5 19	5 24	5 28	5 33	5 37	5 42	5 46	5 50	5 54	5 58	6 01	R.	50
	S.	8 10	8 13	8 10	8 06	8 01	7 56	7 51	7 46	7 41	7 35	7 30	7 24	7 19	7 13	7 08	7 03	6 57	6 52	6 46	6 41	6 35	6 30	6 24	6 19	6 13	S.	
51	R.	3 41	3 50	4 01	4 09	4 17	4 25	4 32	4 38	4 44	4 50	4 56	5 02	5 07	5 12	5 17	5 22	5 27	5 31	5 36	5 41	5 45	5 49	5 53	5 57	6 01	R.	51
	S.	8 16	8 18	8 15	8 10	8 05	8 00	7 55	7 49	7 44	7 38	7 32	7 27	7 21	7 15	7 10	7 04	6 59	6 53	6 48	6 42	6 36	6 30	6 24	6 19	6 13	S.	
52	R.	3 35	3 44	3 55	4 04	4 13	4 21	4 28	4 35	4 41	4 47	4 53	4 59	5 05	5 10	5 15	5 20	5 25	5 30	5 35	5 40	5 44	5 49	5 53	5 57	6 01	R.	52
	S.	8 21	8 23	8 20	8 15	8 10	8 04	7 59	7 53	7 47	7 41	7 35	7 29	7 24	7 18	7 12	7 06	7 00	6 55	6 49	6 43	6 37	6 31	6 25	6 19	6 13	S.	
53	R.	3 29	3 38	3 50	3 59	4 08	4 16	4 24	4 31	4 38	4 44	4 50	4 56	5 02	5 08	5 13	5 18	5 23	5 28	5 33	5 38	5 43	5 48	5 52	5 57	6 01	R.	53
	S.	8 27	8 29	8 26	8 20	8 15	8 09	8 03	7 57	7 51	7 44	7 38	7 32	7 26	7 20	7 14	7 08	7 02	6 56	6 50	6 44	6 38	6 32	6 25	6 19	6 13	S.	
54	R.	3 23	3 32	3 44	3 54	4 03	4 11	4 19	4 27	4 34	4 41	4 47	4 53	4 59	5 05	5 11	5 16	5 22	5 27	5 32	5 37	5 42	5 47	5 52	5 57	6 01	R.	54
	S.	8 34	8 35	8 32	8 26	8 20	8 13	8 07	8 01	7 54	7 48	7 41	7 35	7 29	7 22	7 16	7 10	7 04	6 58	6 51	6 45	6 39	6 32	6 26	6 20	6 14	S.	
55	R.	3 16	3 25	3 38	3 48	3 57	4 06	4 15	4 23	4 30	4 37	4 44	4 50	4 57	5 03	5 09	5 14	5 20	5 25	5 31	5 36	5 41	5 46	5 51	5 56	6 01	R.	55
	S.	8 41	8 42	8 38	8 31	8 25	8 18	8 12	8 05	7 58	7 51	7 45	7 38	7 32	7 25	7 19	7 12	7 06	6 59	6 53	6 46	6 40	6 33	6 26	6 20	6 14	S.	
56	R.	3 08	3 18	3 31	3 42	3 52	4 01	4 10	4 18	4 26	4 33	4 40	4 47	4 54	5 00	5 06	5 12	5 18	5 24	5 29	5 35	5 40	5 46	5 51	5 56	6 01	R.	56
	S.	8 48	8 49	8 44	8 37	8 30	8 23	8 17	8 10	8 03	7 56	7 49	7 42	7 35	7 28	7 21	7 14	7 08	7 01	6 54	6 48	6 41	6 34	6 27	6 21	6 14	S.	
57	R.	3 00	3 11	3 24	3 35	3 45	3 55	4 04	4 13	4 21	4 29	4 36	4 43	4 50	4 57	5 03	5 10	5 16	5 22	5 28	5 34	5 39	5 45	5 50	5 55	6 00	R.	57
	S.	8 56	8 57	8 51	8 44	8 37	8 29	8 22	8 15	8 07	8 00	7 52	7 45	7 38	7 31	7 24	7 17	7 10	7 03	6 56	6 49	6 42	6 35	6 28	6 21	6 14	S.	
58	R.	2 51	3 02	3 16	3 28	3 39	3 49	3 59	4 08	4 16	4 24	4 32	4 40	4 47	4 54	5 01	5 07	5 14	5 20	5 26	5 32	5 38	5 44	5 49	5 55	6 00	R.	58
	S.	9 05	9 06	8 59	8 51	8 43	8 35	8 27	8 20	8 12	8 04	7 56	7 49	7 42	7 34	7 27	7 19	7 12	7 05	6 57	6 50	6 43	6 36	6 29	6 22	6 14	S.	
59	R.	2 42	2 53	3 08	3 20	3 32	3 43	3 53	4 02	4 11	4 19	4 28	4 36	4 43	4 50	4 58	5 05	5 11	5 18	5 24	5 31	5 37	5 43	5 48	5 54	6 00	R.	59
	S.	9 15	9 15	9 08	8 59	8 50	8 42	8 33	8 25	8 17	8 09	8 01	7 53	7 45	7 37	7 30	7 22	7 14	7 07	6 59	6 52	6 44	6 37	6 29	6 22	6 15	S.	
60	R.	2 31	2 42	2 59	3 13	3 25	3 36	3 47	3 57	4 06	4 15	4 23	4 32	4 40	4 47	4 55	5 02	5 09	5 16	5 22	5 29	5 35	5 42	5 48	5 54	6 00	R.	60
	S.	9 26	9 26	9 17	9 07	8 58	8 49	8 40	8 31	8 23	8 14	8 05	7 57	7 49	7 40	7 32	7 24	7 16	7 09	7 01	6 53	6 45	6 38	6 30	6 23	6 15	S.	

TABLE 11.

For reducing the Time of the Moon's passage over the Meridian of Greenwich to the Time of its passage over any other Meridian. The numbers taken from this Table are to be added to the Time at Greenwich in West Longitude, subtracted in East Longitude.

Longitude.	Daily variation of the moon's passing the meridian.														Longitude.
	40m	42m	44m	46m	48m	50m	52m	54m	56m	58m	60m	62m	64m	66m	
°	m.	m.	m.	m.	m.	m.	m.	m.	m.	m.	m.	m.	m.	m.	°
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	5
10	1	1	1	1	1	1	1	1	2	2	2	2	2	2	10
15	2	2	2	3	2	2	2	2	2	2	2	3	3	3	15
20	2	2	2	2	3	3	3	3	3	3	3	3	4	4	20
25	3	3	3	3	3	3	4	4	4	4	4	4	4	5	25
30	3	3	4	4	4	4	4	4	5	5	5	5	5	5	30
35	4	4	4	4	5	5	5	5	5	6	6	6	6	6	35
40	4	5	5	5	5	6	6	6	6	6	7	7	7	7	40
45	5	5	5	6	6	6	6	7	7	7	7	8	8	8	45
50	6	6	6	6	7	7	7	7	8	8	8	9	9	9	50
55	6	6	7	7	7	8	8	8	9	9	9	9	10	10	55
60	7	7	7	8	8	8	9	9	9	10	10	10	11	11	60
65	7	8	8	8	9	9	9	10	10	10	11	11	12	12	65
70	8	8	9	9	9	10	10	10	11	11	12	12	12	13	70
75	8	9	9	10	10	10	11	11	12	12	12	13	13	14	75
80	9	9	10	10	11	11	12	12	12	13	13	14	14	15	80
85	9	10	10	11	11	12	12	13	13	14	14	15	15	16	85
90	10	10	11	11	12	12	13	13	14	14	15	15	16	16	90
95	11	11	12	12	13	13	14	14	15	15	16	16	17	17	95
100	11	12	12	13	13	14	14	15	16	16	17	17	18	18	100
105	12	12	13	13	14	15	15	16	16	17	17	18	19	19	105
110	12	13	13	14	15	15	16	16	17	18	18	19	20	20	110
115	13	13	14	15	15	16	17	17	18	19	19	20	20	21	115
120	13	14	15	15	16	17	17	18	19	19	20	21	21	22	120
125	14	15	15	16	17	17	18	19	19	20	21	22	22	23	125
130	14	15	16	17	17	18	19	19	20	21	22	22	23	24	130
135	15	16	16	17	18	19	19	20	21	22	22	23	24	25	135
140	16	16	17	18	19	19	20	21	22	23	23	24	25	26	140
145	16	17	18	19	19	20	21	22	23	23	24	25	26	27	145
150	17	17	18	19	20	21	22	22	23	24	25	26	27	27	150
155	17	18	19	20	21	22	22	23	24	25	26	27	28	28	155
160	18	19	20	20	21	22	23	24	25	26	27	28	28	29	160
165	18	19	20	21	22	23	24	25	26	27	27	28	29	30	165
170	19	20	21	22	23	24	25	25	26	27	28	29	30	31	170
175	19	20	21	22	23	24	25	26	27	28	29	30	31	32	175
180	20	21	22	23	24	25	26	27	28	29	30	31	32	33	180
	40m	42m	44m	46m	48m	50m	52m	54m	56m	58m	60m	62m	64m	66m	

TABLE 12.

For finding the Variation of the Sun's Right Ascension or Declination, or of the Equation of Time, in any number of minutes of time, the Horary Motion being given at the top of the page in seconds, and the number of minutes of time in the side column. Also for finding the Variation of the Moon's Declination or Right Ascension in seconds of time, the motion in one minute being given at the top, and the numbers in the side column being taken for seconds.

M.	Horary motion.																			M.
	1"	2"	3"	4"	5"	6"	7"	8"	9"	10"	11"	12"	13"	14"	15"	16"	17"	18"	19"	
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	2
3	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	3
4	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	4
5	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	2	2	5
6	0	0	0	0	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	6
7	0	0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	7
8	0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	8
9	0	0	0	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	9
10	0	0	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	3	10
11	0	0	1	1	1	1	1	1	2	2	2	2	2	3	3	3	3	3	3	11
12	0	0	1	1	1	1	1	2	2	2	2	2	3	3	3	3	3	4	4	12
13	0	0	1	1	1	1	2	2	2	2	2	3	3	3	3	3	4	4	4	13
14	0	0	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	4	14
15	0	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	5	5	15
16	0	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	5	5	5	16
17	0	1	1	1	1	2	2	2	3	3	3	3	4	4	4	5	5	5	5	17
18	0	1	1	1	2	2	2	2	3	3	3	4	4	4	5	5	5	5	6	18
19	0	1	1	1	2	2	2	3	3	3	3	4	4	4	5	5	5	6	6	19
20	0	1	1	1	2	2	2	3	3	3	4	4	4	5	5	5	6	6	6	20
21	0	1	1	1	2	2	2	3	3	4	4	4	5	5	5	6	6	6	7	21
22	0	1	1	1	2	2	3	3	3	4	4	4	5	5	6	6	6	7	7	22
23	0	1	1	2	2	2	3	3	3	4	4	5	5	5	6	6	7	7	7	23
24	0	1	1	2	2	2	3	3	4	4	4	5	5	6	6	6	7	7	8	24
25	0	1	1	2	2	3	3	3	4	4	5	5	5	6	6	7	7	8	8	25
26	0	1	1	2	2	3	3	3	4	4	5	5	6	6	7	7	7	8	8	26
27	0	1	1	2	2	3	3	4	4	5	5	5	6	6	7	7	8	8	9	27
28	0	1	1	2	2	3	3	4	4	5	5	6	6	7	7	7	8	8	9	28
29	0	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	29
30	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	30
31	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	31
32	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	9	9	10	10	32
33	1	1	2	2	3	3	4	4	5	6	6	7	7	8	8	9	9	10	10	33
34	1	1	2	2	3	3	4	5	5	6	6	7	7	8	9	9	10	10	11	34
35	1	1	2	2	3	4	4	5	5	6	6	7	8	8	9	9	10	11	11	35
36	1	1	2	2	3	4	4	5	5	6	7	7	8	8	9	10	10	11	11	36
37	1	1	2	2	3	4	4	5	6	6	7	7	8	9	9	10	10	11	12	37
38	1	1	2	3	3	4	4	5	6	6	7	8	8	9	10	10	11	11	12	38
39	1	1	2	3	3	4	5	5	6	7	7	8	8	9	10	10	11	12	12	39
40	1	1	2	3	3	4	5	5	6	7	7	8	9	9	10	11	11	12	13	40
41	1	1	2	3	3	4	5	5	6	7	8	8	9	10	10	11	12	12	13	41
42	1	1	2	3	4	4	5	6	6	7	8	8	9	10	11	11	12	13	13	42
43	1	1	2	3	4	4	5	6	6	7	8	9	9	10	11	11	12	13	14	43
44	1	1	2	3	4	4	5	6	7	7	8	9	10	10	11	12	12	13	14	44
45	1	2	2	3	4	5	5	6	7	8	8	9	10	11	11	12	13	14	14	45
46	1	2	2	3	4	5	5	6	7	8	8	9	10	11	12	12	13	14	15	46
47	1	2	2	3	4	5	5	6	7	8	9	9	10	11	12	13	13	14	15	47
48	1	2	2	3	4	5	6	6	7	8	9	10	10	11	12	13	14	14	15	48
49	1	2	2	3	4	5	6	7	7	8	9	10	11	11	12	13	14	15	16	49
50	1	2	3	3	4	5	6	7	8	8	9	10	11	12	13	13	14	15	16	50
51	1	2	3	3	4	5	6	7	8	9	9	10	11	12	13	14	14	15	16	51
52	1	2	3	3	4	5	6	7	8	9	10	10	11	12	13	14	15	16	16	52
53	1	2	3	4	4	5	6	7	8	9	10	11	11	12	13	14	15	16	17	53
54	1	2	3	4	5	5	6	7	8	9	10	11	12	13	14	14	15	16	17	54
55	1	2	3	4	5	6	6	7	8	9	10	11	12	13	14	15	16	17	17	55
56	1	2	3	4	5	6	7	7	8	9	10	11	12	13	14	15	16	17	18	56
57	1	2	3	4	5	6	7	8	9	10	10	11	12	13	14	15	16	17	18	57
58	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	15	16	17	18	58
59	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	59
60	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	60

TABLE 12.

For finding the Variation of the Sun's Right Ascension or Declination, or of the Equation of Time, in any number of minutes of time, the Horary Motion being given at the top of the page in seconds, and the number of minutes of time in the side column. Also for finding the Variation of the Moon's Declination or Right Ascension in seconds of time, the motion in one minute being given at the top, and the numbers in the side column being taken for seconds.

M.	Horary motion.																	M.
	20″	21″	22″	23″	24″	25″	26″	27″	28″	29″	30″	31″	32″	33″	34″	35″	30″	
1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2
3	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3
4	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	4
5	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	5
6	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	4	4	6
7	2	2	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	7
8	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	8
9	3	3	3	3	4	4	4	4	4	4	5	5	5	5	5	5	5	9
10	3	4	4	4	4	4	4	5	5	5	5	5	5	6	6	6	6	10
11	4	4	4	4	4	5	5	5	5	5	6	6	6	6	6	6	7	11
12	4	4	4	5	5	5	5	5	6	6	6	6	6	7	7	7	7	12
13	4	5	5	5	5	5	6	6	6	6	7	7	7	7	7	8	8	13
14	5	5	5	5	6	6	6	6	7	7	7	7	7	8	8	8	8	14
15	5	5	6	6	6	6	7	7	7	7	8	8	8	8	9	9	9	15
16	5	6	6	6	6	7	7	7	7	8	8	8	9	9	9	9	10	16
17	6	6	6	7	7	7	7	8	8	8	9	9	9	9	10	10	10	17
18	6	6	7	7	7	8	8	8	8	9	9	9	10	10	10	11	11	18
19	6	7	7	7	8	8	8	9	9	9	10	10	10	10	11	11	11	19
20	7	7	7	8	8	8	9	9	9	10	10	10	11	11	11	12	12	20
21	7	7	8	8	8	9	9	9	10	10	11	11	11	12	12	12	13	21
22	7	8	8	8	9	9	10	10	10	11	11	11	12	12	12	13	13	22
23	8	8	8	9	9	10	10	10	11	11	12	12	12	13	13	13	14	23
24	8	8	9	9	10	10	10	11	11	12	12	12	13	13	14	14	14	24
25	8	9	9	10	10	10	11	11	12	12	13	13	13	14	14	15	15	25
26	9	9	10	10	10	11	11	12	12	13	13	13	14	14	15	15	16	26
27	9	9	10	10	11	11	12	12	13	13	14	14	14	15	15	16	16	27
28	9	10	10	11	11	12	12	13	13	14	14	14	15	15	16	16	17	28
29	10	10	11	11	12	12	13	13	14	14	15	15	15	16	16	17	17	29
30	10	11	11	12	12	13	13	14	14	15	15	16	16	17	17	18	18	30
31	10	11	11	12	12	13	13	14	14	15	16	16	17	17	18	18	19	31
32	11	11	12	12	13	13	14	14	15	15	16	17	17	18	18	19	19	32
33	11	12	12	13	13	14	14	15	15	16	17	17	18	18	19	19	20	33
34	11	12	12	13	14	14	15	15	16	16	17	18	18	19	19	20	20	34
35	12	12	13	13	14	15	15	16	16	17	18	18	19	19	20	20	21	35
36	12	13	13	14	14	15	16	16	17	17	18	19	19	20	20	21	22	36
37	12	13	14	14	15	15	16	17	17	18	19	19	20	20	21	22	22	37
38	13	13	14	15	15	16	16	17	18	18	19	20	20	21	22	22	23	38
39	13	14	14	15	16	16	17	18	18	19	20	20	21	21	22	23	23	39
40	13	14	15	15	16	17	17	18	19	19	20	21	21	22	23	23	24	40
41	14	14	15	16	16	17	18	18	19	20	21	21	22	23	23	24	25	41
42	14	15	15	16	17	18	18	19	20	20	21	22	22	23	24	25	25	42
43	14	15	16	16	17	18	19	19	20	21	22	22	23	24	24	25	26	43
44	15	15	16	17	18	18	19	20	21	21	22	23	23	24	25	26	26	44
45	15	16	17	17	18	19	20	20	21	22	23	23	24	25	26	26	27	45
46	15	16	17	18	18	19	20	21	21	22	23	24	25	25	26	27	28	46
47	16	16	17	18	19	20	20	21	22	23	24	24	25	26	27	27	28	47
48	16	17	18	18	19	20	21	22	22	23	24	25	26	26	27	28	29	48
49	16	17	18	19	20	20	21	22	23	24	25	25	26	27	28	29	29	49
50	17	18	18	19	20	21	22	23	23	24	25	26	27	28	28	29	30	50
51	17	18	19	20	20	21	22	23	24	25	26	26	27	28	29	30	31	51
52	17	18	19	20	21	22	23	23	24	25	26	27	28	29	29	30	31	52
53	18	19	19	20	21	22	23	24	25	26	27	27	28	29	30	31	32	53
54	18	19	20	21	22	23	23	24	25	26	27	28	29	30	31	32	32	54
55	18	19	20	21	22	23	24	25	26	27	28	28	29	30	31	32	33	55
56	19	20	21	21	22	23	24	25	26	27	28	29	30	31	32	33	34	56
57	19	20	21	22	23	24	25	26	27	28	29	29	30	31	32	33	34	57
58	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	58
59	20	21	22	23	24	25	26	27	28	29	30	30	31	32	33	34	35	59
60	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	60

TABLE 12.

For finding the Variation of the Sun's Right Ascension or Declination, or of the Equation of Time, in any number of minutes of time, the Horary Motion being given at the top of the page in seconds, and the number of minutes of time in the side column. Also for finding the Variation of the Moon's Declination or Right Ascension in seconds of time, the motion in one minute being given at the top, and the numbers in the side column being taken for seconds.

M.	Horary motion.																	M.
	37″	38″	39″	40″	41″	42″	43″	44″	45″	46″	47″	48″	49″	50″	51″	52″	53″	
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2
3	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3
4	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4
5	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	5
6	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5	6
7	4	4	5	5	5	5	5	5	5	5	5	6	6	6	6	6	6	7
8	5	5	5	5	5	6	6	6	6	6	6	6	7	7	7	7	7	8
9	6	6	6	6	6	6	6	7	7	7	7	7	7	8	8	8	8	9
10	6	6	7	7	7	7	7	7	8	8	8	8	8	8	9	9	9	10
11	7	7	7	7	8	8	8	8	8	8	9	9	9	9	9	10	10	11
12	7	8	8	8	8	8	9	9	9	9	9	10	10	10	10	10	11	12
13	8	8	8	9	9	9	9	10	10	10	10	10	11	11	11	11	11	13
14	9	9	9	9	10	10	10	10	11	11	11	11	11	12	12	12	12	14
15	9	10	10	10	10	11	11	11	11	12	12	12	12	13	13	13	13	15
16	10	10	10	11	11	11	11	12	12	12	13	13	13	13	14	14	14	16
17	10	11	11	11	12	12	12	12	13	13	13	14	14	14	14	15	15	17
18	11	11	12	12	12	13	13	13	14	14	14	14	15	15	15	16	16	18
19	12	12	12	13	13	13	14	14	14	15	15	15	16	16	16	16	17	19
20	12	13	13	13	14	14	14	15	15	15	16	16	16	17	17	17	18	20
21	13	13	14	14	14	15	15	15	16	16	16	17	17	18	18	18	19	21
22	14	14	14	15	15	15	16	16	17	17	17	18	18	18	19	19	19	22
23	14	15	15	15	16	16	16	17	17	18	18	18	19	19	20	20	20	23
24	15	15	16	16	16	17	17	18	18	18	19	19	20	20	20	21	21	24
25	15	16	16	17	17	18	18	18	19	19	20	20	20	21	21	22	22	25
26	16	16	17	17	18	18	19	19	20	20	20	21	21	22	22	23	23	26
27	17	17	18	18	18	19	19	20	20	21	21	22	22	23	23	23	24	27
28	17	18	18	19	19	20	20	21	21	21	22	22	23	23	24	24	25	28
29	18	18	19	19	20	20	21	21	22	22	23	23	24	24	25	25	26	29
30	19	19	20	20	21	21	22	22	23	23	24	24	25	25	26	26	27	30
31	19	20	20	21	21	22	22	23	23	24	24	25	25	26	26	27	27	31
32	20	20	21	21	22	22	23	23	24	25	25	26	26	27	27	28	28	32
33	20	21	21	22	23	23	24	24	25	25	26	26	27	28	28	29	29	33
34	21	22	22	23	23	24	24	25	26	26	27	27	28	28	29	29	30	34
35	22	22	23	23	24	25	25	26	26	27	27	28	29	29	30	30	31	35
36	22	23	23	24	25	25	26	26	27	28	28	29	29	30	31	31	32	36
37	23	23	24	25	25	26	27	27	28	28	29	30	30	31	31	32	33	37
38	23	24	25	25	26	27	27	28	29	29	30	30	31	32	32	33	34	38
39	24	25	25	26	27	27	28	29	29	30	31	31	32	33	33	34	34	39
40	25	25	26	27	27	28	29	29	30	31	31	32	33	33	34	35	35	40
41	25	26	27	27	28	29	29	30	31	31	32	33	33	34	35	36	36	41
42	26	27	27	28	29	29	30	31	32	32	33	34	34	35	36	36	37	42
43	27	27	28	29	29	30	31	32	32	33	34	34	35	36	37	37	38	43
44	27	28	29	29	30	31	32	32	33	34	34	35	36	37	37	38	39	44
45	28	29	29	30	31	32	32	33	34	35	35	36	37	38	38	39	40	45
46	28	29	30	31	31	32	33	34	35	35	36	37	38	38	39	40	41	46
47	29	30	31	31	32	33	34	34	35	36	37	38	38	39	40	41	42	47
48	30	30	31	32	33	34	34	35	36	37	38	38	39	40	41	42	42	48
49	30	31	32	33	33	34	35	36	37	38	38	39	40	41	42	42	43	49
50	31	32	33	33	34	35	36	37	38	38	39	40	41	42	43	43	44	50
51	31	32	33	34	35	36	37	37	38	39	40	41	42	43	43	44	45	51
52	32	33	34	35	36	36	37	38	39	40	41	42	42	43	44	45	46	52
53	33	34	34	35	36	37	38	39	40	41	42	42	43	44	45	46	47	53
54	33	34	35	36	37	38	39	40	41	41	42	43	44	45	46	47	48	54
55	34	35	36	37	38	39	39	40	41	42	43	44	45	46	47	48	49	55
56	35	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	49	56
57	35	36	37	38	39	40	41	42	43	44	45	46	47	48	48	49	50	57
58	36	37	38	39	40	41	42	43	44	44	45	46	47	48	49	50	51	58
59	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	59
60	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	60

TABLE 12.

For finding the Variation of the Sun's Right Ascension or Declination, or of the Equation of Time, in any number of minutes of time, the Horary Motion being given at the top of the page in seconds, and the number of minutes of time in the side column. Also for finding the Variation of the Moon's Declination or Right Ascension in seconds of time, the motion in one minute being given at the top, and the numbers in the side column being taken for seconds.

M.	Horary motion.																	M.
	54″	55″	56″	57″	58″	59″	60″	61″	62″	63″	64″	65″	66″	67″	68″	69″	70″	
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	3
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	4
5	5	5	5	5	5	5	5	5	5	5	5	5	6	6	6	6	6	5
6	5	6	6	6	6	6	6	6	6	6	6	7	7	7	7	7	7	6
7	6	6	7	7	7	7	7	7	7	7	7	8	8	8	8	8	8	7
8	7	7	7	8	8	8	8	8	8	8	9	9	9	9	9	9	9	8
9	8	8	8	9	9	9	9	9	9	9	10	10	10	10	10	10	11	9
10	9	9	9	10	10	10	10	10	10	11	11	11	11	11	11	12	12	10
11	10	10	10	10	11	11	11	11	11	12	12	12	12	12	12	13	13	11
12	11	11	11	11	12	12	12	12	12	13	13	13	13	13	14	14	14	12
13	12	12	12	12	13	13	13	13	13	14	14	14	14	15	15	15	15	13
14	13	13	13	13	14	14	14	14	14	15	15	15	15	16	16	16	16	14
15	14	14	14	14	15	15	15	15	16	16	16	16	17	17	17	17	18	15
16	14	15	15	15	15	16	16	16	17	17	17	17	18	18	18	18	19	16
17	15	16	16	16	16	17	17	17	18	18	18	18	19	19	19	20	20	17
18	16	17	17	17	17	18	18	18	19	19	19	20	20	20	20	21	21	18
19	17	17	18	18	18	19	19	19	20	20	20	21	21	21	22	22	22	19
20	18	18	19	19	19	20	20	20	21	21	21	22	22	22	23	23	23	20
21	19	19	20	20	20	21	21	21	22	22	22	23	23	23	24	24	25	21
22	20	20	21	21	21	22	22	22	23	23	23	24	24	25	25	25	26	22
23	21	21	21	22	22	23	23	23	24	24	25	25	25	26	26	26	27	23
24	22	22	22	23	23	24	24	24	25	25	26	26	26	27	27	28	28	24
25	23	23	23	24	24	25	25	25	26	26	27	27	28	28	28	29	29	25
26	23	24	24	25	25	26	26	26	27	27	28	28	29	29	29	30	30	26
27	24	25	25	26	26	27	27	27	28	28	29	29	30	50	31	31	32	27
28	25	26	26	27	27	28	28	28	29	29	30	30	31	31	32	32	33	28
29	26	27	27	28	28	29	29	29	30	30	31	31	32	32	33	33	34	29
30	27	28	28	29	29	30	30	31	31	32	32	33	33	34	34	35	35	30
31	28	28	29	29	30	30	31	32	32	33	33	34	34	35	35	36	36	31
32	29	29	30	30	31	31	32	33	33	34	34	35	35	36	36	37	37	32
33	30	30	31	31	32	32	33	34	34	35	35	36	36	37	37	38	39	33
34	31	31	32	32	33	33	34	35	35	36	36	37	37	38	39	39	40	34
35	32	32	33	33	34	34	35	36	36	37	37	38	39	39	40	40	41	35
36	32	33	34	34	35	35	36	37	37	38	38	39	40	40	41	41	42	36
37	33	34	35	35	36	36	37	38	38	39	39	40	41	41	42	43	43	37
38	34	35	35	36	37	37	38	39	39	40	41	41	42	42	43	44	44	38
39	35	36	36	37	38	38	39	40	40	41	42	42	43	44	44	45	46	39
40	36	37	37	38	39	39	40	41	41	42	43	43	44	45	45	46	47	40
41	37	38	38	39	40	40	41	42	42	43	44	44	45	46	46	47	48	41
42	38	39	39	40	41	41	42	43	43	44	45	46	46	47	48	48	49	42
43	39	39	40	41	42	42	43	44	44	45	46	47	47	48	49	49	50	43
44	40	40	41	42	43	43	44	45	45	46	47	48	48	49	50	51	51	44
45	41	41	42	43	44	44	45	46	47	47	48	49	50	50	51	52	53	45
46	41	42	43	44	44	45	46	47	48	48	49	50	51	51	52	53	54	46
47	42	43	44	45	45	46	47	48	49	49	50	51	52	52	53	54	55	47
48	43	44	45	46	46	47	48	49	50	50	51	52	53	54	54	55	56	48
49	44	45	46	47	47	48	49	50	51	51	52	53	54	55	56	56	57	49
50	45	46	47	48	48	49	50	51	52	53	53	54	55	56	57	58	58	50
51	46	47	48	48	49	50	51	52	53	54	54	55	56	57	58	59	60	51
52	47	48	49	49	50	51	52	53	54	55	55	56	57	58	59	60	61	52
53	48	49	49	50	51	52	53	54	55	56	57	57	58	59	60	61	62	53
54	49	50	50	51	52	53	54	55	56	57	58	59	59	60	61	62	63	54
55	50	50	51	52	53	54	55	56	57	58	59	60	61	61	62	63	64	55
56	50	51	52	53	54	55	56	57	58	59	60	61	62	63	63	64	65	56
57	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	57
58	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	58
59	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	59
60	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	60

TABLE 12.

For finding the Variation of the Sun's Right Ascension or Declination, or of the Equation of Time, in any number of minutes of time, the Horary Motion being given at the top of the page in seconds, and the number of minutes of time in the side column. Also for finding the Variation of the Moon's Declination or Right Ascension in seconds of time, the motion in one minute being given at the top, and the numbers in the side column being taken for seconds.

M.	Horary motion.																	M.
	71″	72″	73″	74″	75″	76″	77″	78″	79″	80″	81″	82″	83″	84″	85″	86″	87″	
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	2
3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3
4	5	5	5	5	5	5	5	5	5	5	5	5	6	6	6	6	6	4
5	6	6	6	6	6	6	6	7	7	7	7	7	7	7	7	7	7	5
6	7	7	7	7	8	8	8	8	8	8	8	8	8	8	9	9	9	6
7	8	8	9	9	9	9	9	9	9	9	9	10	10	10	10	10	10	7
8	9	10	10	10	10	10	10	10	11	11	11	11	11	11	11	11	12	8
9	11	11	11	11	11	11	12	12	12	12	12	12	12	13	13	13	13	9
10	12	12	12	12	13	13	13	13	13	13	14	14	14	14	14	14	15	10
11	13	13	13	14	14	14	14	14	14	15	15	15	15	15	16	16	16	11
12	14	14	15	15	15	15	15	16	16	16	16	16	17	17	17	17	17	12
13	15	16	16	16	16	16	17	17	17	17	18	18	18	18	18	19	19	13
14	17	17	17	17	18	18	18	18	18	19	19	19	19	20	20	20	20	14
15	18	18	18	19	19	19	19	20	20	20	20	21	21	21	21	22	22	15
16	19	19	19	20	20	20	21	21	21	21	22	22	22	22	23	23	23	16
17	20	20	21	21	21	22	22	22	22	23	23	23	24	24	24	24	25	17
18	21	22	22	22	23	23	23	23	24	24	24	25	25	25	26	26	26	18
19	22	23	23	23	24	24	24	25	25	25	26	26	26	27	27	27	28	19
20	24	24	24	25	25	25	26	26	26	27	27	27	28	28	28	29	29	20
21	25	25	26	26	26	27	27	27	28	28	28	29	29	29	30	30	30	21
22	26	26	27	27	28	28	28	29	29	29	30	30	30	31	31	32	32	22
23	27	28	28	28	29	29	30	30	30	31	31	31	32	32	33	33	33	23
24	28	29	29	30	30	30	31	31	32	32	32	33	33	34	34	34	34	24
25	30	30	30	31	31	32	32	33	33	33	34	34	35	35	35	36	36	25
26	31	31	32	32	33	33	33	34	34	35	35	36	36	36	37	37	38	26
27	32	32	33	33	34	34	35	35	36	36	36	37	37	38	38	39	39	27
28	33	34	34	35	35	35	36	36	37	37	38	38	39	39	40	40	41	28
29	34	35	35	36	36	37	37	38	38	39	39	40	40	41	41	42	42	29
30	36	36	37	37	38	38	39	39	40	40	41	41	42	42	43	43	44	30
31	37	37	38	38	39	39	40	40	41	41	42	42	43	43	44	44	45	31
32	38	38	39	39	40	41	41	42	42	43	43	44	44	45	45	46	46	32
33	39	40	40	41	41	42	42	43	43	44	45	45	46	46	47	47	48	33
34	40	41	41	42	43	43	44	44	45	45	46	46	47	48	48	49	49	34
35	41	42	43	43	44	44	45	46	46	47	47	48	48	49	50	50	51	35
36	43	43	44	44	45	46	46	47	47	48	49	49	50	50	51	52	52	36
37	44	44	45	46	46	47	47	48	49	49	50	51	51	52	52	53	54	37
38	45	46	46	47	48	48	49	49	50	51	51	52	53	53	54	54	55	38
39	46	47	47	48	49	49	50	51	51	52	53	53	54	55	55	56	57	39
40	47	48	49	49	50	51	51	52	53	53	54	55	55	56	57	57	58	40
41	49	49	50	51	51	52	53	53	54	55	55	56	57	57	58	59	59	41
42	50	50	51	52	53	53	54	55	55	56	57	57	58	59	60	60	61	42
43	51	52	52	53	54	54	55	56	57	57	58	59	59	60	61	62	62	43
44	52	53	54	54	55	56	56	57	58	59	59	60	61	62	62	63	64	44
45	53	54	55	56	56	57	58	59	59	60	61	62	62	63	64	65	65	45
46	54	55	56	57	58	58	59	60	61	61	62	63	64	64	65	66	67	46
47	56	56	57	58	59	60	60	61	62	63	63	64	65	66	67	67	68	47
48	57	58	58	59	60	61	62	62	63	64	65	66	66	67	68	69	70	48
49	58	59	60	60	61	62	63	64	65	65	66	67	68	69	69	70	71	49
50	59	60	61	62	63	63	64	65	66	67	68	68	69	70	71	72	73	50
51	60	61	62	63	64	65	65	66	67	68	69	70	71	71	72	73	74	51
52	62	62	63	64	65	66	67	68	68	69	70	71	72	73	74	75	75	52
53	63	64	64	65	66	67	68	69	70	71	72	72	73	74	75	76	77	53
54	64	65	66	67	68	68	69	70	71	72	73	74	75	76	77	77	78	54
55	65	66	67	68	69	70	71	72	72	73	74	75	76	77	78	79	80	55
56	66	67	68	69	70	71	72	73	74	75	76	77	77	78	79	80	81	56
57	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	57
58	69	70	71	72	73	73	74	75	76	77	78	79	80	81	82	83	84	58
59	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	59
60	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	60

TABLE 12.

For finding the Variation of the Sun's Right Ascension or Declination, or of the Equation of Time, in any number of minutes of time, the Horary Motion being given at the top of the page in seconds, and the number of minutes of time in the side column. Also for finding the Variation of the Moon's Declination or Right Ascension, in seconds of time, the motion in one minute being given at the top and the numbers in the side column being taken for seconds.

M.	Horary motion.																	M.
	88″	89″	90″	91″	92″	93″	94″	95″	96″	97″	98″	99″	100″	101″	102″	103″	104″	
1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1
2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2
3	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	3
4	6	6	6	6	6	6	6	6	6	6	7	7	7	7	7	7	7	4
5	7	7	8	8	8	8	8	8	8	8	8	8	8	8	9	9	9	5
6	9	9	9	9	9	9	9	10	10	10	10	10	10	10	10	10	10	6
7	10	10	11	11	11	11	11	11	11	11	11	12	12	12	12	12	12	7
8	12	12	12	12	12	12	13	13	13	13	13	13	13	13	14	14	14	8
9	13	13	14	14	14	14	14	14	14	15	15	15	15	15	15	15	16	9
10	15	15	15	15	15	16	16	16	16	16	16	17	17	17	17	17	17	10
11	16	16	17	17	17	17	17	17	18	18	18	18	18	19	19	19	19	11
12	18	18	18	18	18	19	19	19	19	19	20	20	20	20	20	21	21	12
13	19	19	20	20	20	20	20	21	21	21	21	21	22	22	22	22	23	13
14	21	21	21	21	21	22	22	22	22	23	23	23	23	24	24	24	24	14
15	22	22	23	23	23	23	24	24	24	24	25	25	25	25	26	26	26	15
16	23	24	24	24	25	25	25	25	26	26	26	26	27	27	27	27	28	16
17	25	25	26	26	26	26	27	27	27	27	28	28	28	29	29	29	29	17
18	26	27	27	27	28	28	28	29	29	29	29	30	30	30	31	31	31	18
19	28	28	29	29	29	29	30	30	30	31	31	31	32	32	32	33	33	19
20	29	30	30	30	31	31	31	32	32	32	33	33	33	34	34	34	35	20
21	31	31	32	32	32	33	33	33	34	34	34	35	35	35	36	36	36	21
22	32	33	33	33	34	34	34	35	35	36	36	36	37	37	37	38	38	22
23	34	34	35	35	35	36	36	36	37	37	38	38	38	39	39	39	40	23
24	35	36	36	36	37	37	38	38	38	39	39	40	40	40	41	41	42	24
25	37	37	38	38	38	39	39	40	40	40	41	41	42	42	43	43	43	25
26	38	39	39	39	40	40	41	41	42	42	42	43	43	44	44	45	45	26
27	40	40	41	41	41	42	42	43	43	44	44	45	45	45	46	46	47	27
28	41	42	42	42	43	43	44	44	45	45	46	46	47	47	48	48	49	28
29	43	43	44	44	44	45	45	46	46	47	47	48	48	49	49	50	50	29
30	44	45	45	46	46	47	47	48	48	49	49	50	50	51	51	52	52	30
31	45	46	47	47	48	48	49	49	50	50	51	51	52	52	53	53	54	31
32	47	47	48	49	49	50	50	51	51	52	52	53	53	54	54	55	55	32
33	48	49	50	50	51	51	52	52	53	53	54	54	55	56	56	57	57	33
34	50	50	51	52	52	53	53	54	54	55	56	56	57	57	58	58	59	34
35	51	52	53	53	54	54	55	55	56	57	57	58	58	59	60	60	61	35
36	53	53	54	55	55	56	56	57	58	58	59	59	60	61	61	62	62	36
37	54	55	56	56	57	57	58	59	59	60	60	61	62	62	63	64	64	37
38	56	56	57	58	58	59	60	60	61	61	62	63	63	64	65	65	66	38
39	57	58	59	59	60	60	61	62	62	63	64	64	65	66	66	67	68	39
40	59	59	60	61	61	62	63	63	64	65	65	66	67	67	68	69	69	40
41	60	61	62	62	63	64	64	65	66	66	67	68	68	69	70	70	71	41
42	62	62	63	64	64	65	66	67	67	68	69	69	70	71	71	72	73	42
43	63	64	65	65	66	67	67	68	69	70	70	71	72	72	73	74	75	43
44	65	65	66	67	67	68	69	70	70	71	72	73	73	74	75	76	76	44
45	66	67	68	68	69	70	71	71	72	73	74	74	75	76	77	77	78	45
46	67	68	69	70	71	71	72	73	74	74	75	76	77	77	78	79	80	46
47	69	70	71	71	72	73	74	74	75	76	77	78	78	79	80	81	81	47
48	70	71	72	73	74	74	75	76	77	78	78	79	80	81	82	82	83	48
49	72	73	74	74	75	76	77	78	78	79	80	81	82	82	83	84	85	49
50	73	74	75	76	77	78	78	79	80	81	82	83	83	84	85	86	87	50
51	75	76	77	77	78	79	80	81	82	82	83	84	85	86	87	88	88	51
52	76	77	78	79	80	81	81	82	83	84	85	86	87	88	88	89	90	52
53	78	79	80	80	81	82	83	84	85	86	87	87	88	89	90	91	92	53
54	79	80	81	82	83	84	85	86	86	87	88	89	90	91	92	93	94	54
55	81	82	83	83	84	85	86	87	88	89	90	91	92	93	94	94	95	55
56	82	83	84	85	86	87	88	89	90	91	91	92	93	94	95	96	97	56
57	84	85	86	86	87	88	89	90	91	92	93	94	95	96	97	98	99	57
58	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	58
59	87	88	89	90	90	91	92	93	94	95	96	97	98	99	100	101	102	59
60	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	60

TABLE 12.

For finding the Variation of the Sun's Right Ascension or Declination, or of the Equation of Time, in any number of minutes of time, the Horary Motion being given at the top of the page in seconds, and the number of minutes of time in the side column. Also for finding the Variatior of the Moon's Declination or Right Ascension, in seconds of time, the motion in one minute being given at the top and the numbers in the side column being taken for seconds.

M.	Horary motion.														M.
	105″	106″	107″	108″	109″	110″	111″	112″	113″	114″	115″	116″	117″	118″	
1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1
2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	2
3	5	5	5	5	5	6	6	6	6	6	6	6	6	6	3
4	7	7	7	7	7	7	7	7	8	8	8	8	8	8	4
5	9	9	9	9	9	9	9	9	9	10	10	10	10	10	5
6	11	11	11	11	11	11	11	11	11	11	12	12	12	12	6
7	12	12	12	13	13	13	13	13	13	13	13	14	14	14	7
8	14	14	14	14	15	15	15	15	15	15	15	15	16	16	8
9	16	16	16	16	16	17	17	17	17	17	17	17	18	18	9
10	18	18	18	18	18	18	19	19	19	19	19	19	20	20	10
11	19	19	20	20	20	20	20	21	21	21	21	21	21	22	11
12	21	21	21	22	22	22	22	22	23	23	23	23	23	24	12
13	23	23	23	23	24	24	24	24	24	25	25	25	25	26	13
14	25	25	25	25	25	26	26	26	26	27	27	27	27	28	14
15	26	27	27	27	27	28	28	28	28	29	29	29	29	30	15
16	28	28	29	29	29	29	30	30	30	30	31	31	31	31	16
17	30	30	30	31	31	31	31	32	32	32	33	33	33	33	17
18	32	32	32	32	33	33	33	34	34	34	35	35	35	35	18
19	33	34	34	34	35	35	35	35	36	36	36	37	37	37	19
20	35	35	36	36	36	37	37	37	38	38	38	39	39	39	20
21	37	37	37	38	38	39	39	39	40	40	40	41	41	41	21
22	39	39	39	40	40	40	41	41	41	42	42	43	43	43	22
23	40	41	41	41	42	42	43	43	43	44	44	44	45	45	23
24	42	42	43	43	44	44	44	45	45	46	46	46	47	47	24
25	44	44	45	45	45	46	46	47	47	48	48	48	49	49	25
26	46	46	46	47	47	48	48	49	49	49	50	50	51	51	26
27	47	48	48	49	49	50	50	50	51	51	52	52	53	53	27
28	49	49	50	50	51	51	52	52	53	53	54	54	55	55	28
29	51	51	52	52	53	53	54	54	55	55	56	56	57	57	29
30	53	53	54	54	55	55	56	56	57	57	58	58	59	59	30
31	54	55	55	56	56	57	57	58	58	59	59	60	60	61	31
32	56	57	57	58	58	59	59	60	60	61	61	62	62	63	32
33	58	58	59	59	60	61	61	62	62	63	63	64	64	65	33
34	60	60	61	61	62	62	63	63	64	65	65	66	66	67	34
35	61	62	62	63	64	64	65	65	66	67	67	68	68	69	35
36	63	64	64	65	65	66	67	67	68	68	69	70	70	71	36
37	65	65	66	67	67	68	68	69	70	70	71	72	72	73	37
38	67	67	68	68	69	70	70	71	72	72	73	73	74	75	38
39	68	69	70	70	71	72	72	73	73	74	75	75	76	77	39
40	70	71	71	72	73	73	74	75	75	76	77	77	78	79	40
41	72	72	73	74	74	75	76	77	77	78	79	79	80	81	41
42	74	74	75	76	76	77	78	78	79	80	81	81	82	83	42
43	75	76	77	77	78	79	80	80	81	82	82	83	84	85	43
44	77	78	78	79	80	81	81	82	83	84	84	85	86	87	44
45	79	80	80	81	82	83	83	84	85	86	86	87	88	89	45
46	81	81	82	83	84	84	85	86	87	87	88	89	90	90	46
47	82	83	84	85	85	86	87	88	89	89	90	91	92	92	47
48	84	85	86	86	87	88	89	90	90	91	92	93	94	94	48
49	86	87	87	88	89	90	91	91	92	93	94	95	96	96	49
50	88	88	89	90	91	92	93	93	94	95	96	97	98	98	50
51	89	90	91	92	93	94	94	95	96	97	98	99	99	100	51
52	91	92	93	94	94	95	96	97	98	99	100	101	101	102	52
53	93	94	95	95	96	97	98	99	100	101	102	102	103	104	53
54	95	95	96	97	98	99	100	101	102	103	104	104	105	106	54
55	96	97	98	99	100	101	102	103	104	105	105	106	107	108	55
56	98	99	100	101	102	103	104	105	105	106	107	108	109	110	56
57	100	101	102	103	104	105	105	106	107	108	109	110	111	112	57
58	102	102	103	104	105	106	107	108	109	110	111	112	113	114	58
59	103	104	105	106	107	108	109	110	111	112	113	114	115	116	59
60	105	106	107	108	109	110	111	112	113	114	115	116	117	118	60

TABLE 12.

For finding the Variation of the Sun's Right Ascension or Declination, or of the Equation of Time, in any number of minutes of time, the Horary Motion being given at the top of the page in seconds, and the number of minutes of time in the side column. Also for finding the Variation of the Moon's Declination or Right Ascension in seconds of time, the motion in one minute being given at the top, and the numbers in the side column being taken for seconds.

M.	Horary motion.														M.
	119″	120″	121″	122″	123″	124″	125″	126″	127″	128″	129″	130″	131″	132″	
1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1
2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	2
3	6	6	6	6	6	6	6	6	6	6	6	7	7	7	3
4	8	8	8	8	8	8	8	8	8	9	9	9	9	9	4
5	10	10	10	10	10	10	10	11	11	11	11	11	11	11	5
6	12	12	12	12	12	12	13	13	13	13	13	13	13	13	6
7	14	14	14	14	14	14	15	15	15	15	15	15	15	15	7
8	16	16	16	16	16	17	17	17	17	17	17	17	17	18	8
9	18	18	18	18	18	19	19	19	19	19	19	20	20	20	9
10	20	20	20	20	21	21	21	21	21	21	22	22	22	22	10
11	22	22	22	22	23	23	23	23	23	23	24	24	24	24	11
12	24	24	24	24	25	25	25	25	25	26	26	26	26	26	12
13	26	26	26	26	27	27	27	27	28	28	28	28	28	29	13
14	28	28	28	28	29	29	29	29	30	30	30	30	31	31	14
15	30	30	30	31	31	31	31	32	32	32	32	33	33	33	15
16	32	32	32	33	33	33	33	34	34	34	34	35	35	35	16
17	34	34	34	35	35	35	35	36	36	36	37	37	37	37	17
18	36	36	36	37	37	37	38	38	38	38	39	39	39	40	18
19	38	38	38	39	39	39	40	40	40	41	41	41	41	42	19
20	40	40	40	41	41	41	42	42	42	43	43	43	44	44	20
21	42	42	42	43	43	43	44	44	44	45	45	46	46	46	21
22	44	44	44	45	45	45	46	46	47	47	47	48	48	48	22
23	46	46	46	47	47	48	48	48	49	49	49	50	50	51	23
24	48	48	48	49	49	50	50	50	51	51	52	52	52	53	24
25	50	50	50	51	51	52	52	53	53	53	54	54	55	55	25
26	52	52	52	53	53	54	54	55	55	55	56	56	57	57	26
27	54	54	54	55	55	56	56	57	57	58	58	59	59	59	27
28	56	56	56	57	57	58	58	59	59	60	60	61	61	62	28
29	58	58	58	59	59	60	60	61	61	62	62	63	63	64	29
30	60	60	61	61	62	62	63	63	64	64	65	65	66	66	30
31	61	62	63	63	64	64	65	65	66	66	67	67	68	68	31
32	63	64	65	65	66	66	67	67	68	68	69	69	70	70	32
33	65	66	67	67	68	68	69	69	70	70	71	72	72	73	33
34	67	68	69	69	70	70	71	71	72	73	73	74	74	75	34
35	69	70	71	71	72	72	73	74	74	75	75	76	76	77	35
36	71	72	73	73	74	74	75	76	76	77	77	78	79	79	36
37	73	74	75	75	76	76	77	78	78	79	80	80	81	81	37
38	75	76	77	77	78	79	79	80	80	81	82	82	83	84	38
39	77	78	79	79	80	81	81	82	83	83	84	85	85	86	39
40	79	80	81	81	82	83	83	84	85	85	86	87	87	88	40
41	81	82	83	83	84	85	85	86	87	87	88	89	90	90	41
42	83	84	85	85	86	87	88	88	89	90	90	91	92	92	42
43	85	86	87	87	88	89	90	90	91	92	92	93	94	95	43
44	87	88	89	89	90	91	92	92	93	94	95	95	96	97	44
45	89	90	91	92	92	93	94	95	95	96	97	98	98	99	45
46	91	92	93	94	94	95	96	97	97	98	99	100	100	101	46
47	93	94	95	96	96	97	98	99	99	100	101	102	103	103	47
48	95	96	97	98	98	99	100	101	102	102	103	104	105	106	48
49	97	98	99	100	100	101	102	103	104	105	105	106	107	108	49
50	99	100	101	102	103	103	104	105	106	107	108	108	109	110	50
51	101	102	103	104	105	105	106	107	108	109	110	111	111	112	51
52	103	104	105	106	107	107	108	109	110	111	112	113	114	114	52
53	105	106	107	108	109	110	110	111	112	113	114	115	116	117	53
54	107	108	109	110	111	112	113	113	114	115	116	117	118	119	54
55	109	110	111	112	113	114	115	116	116	117	118	119	120	121	55
56	111	112	113	114	115	116	117	118	119	119	120	121	122	123	56
57	113	114	115	116	117	118	119	120	121	122	123	124	124	125	57
58	115	116	117	118	119	120	121	122	123	124	125	126	127	128	58
59	117	118	119	120	121	122	123	124	125	126	127	128	129	130	59
60	119	120	121	122	123	124	125	126	127	128	129	130	131	132	60

TABLE 12.

For finding the Variation of the Sun's Right Ascension or Declination, or of the Equation of Time, in any number of minutes of time, the Horary Motion being given at the top of the page in seconds, and the number of minutes of time in the side column. Also for finding the Variation of the Moon's Declination or Right Ascension in seconds of time, the motion in one minute being given at the top, and the numbers in the side column being taken for seconds.

M.	Horary motion.														M.
	133″	134″	135″	136″	137″	138″	139″	140″	141″	142″	143″	144″	145″	146″	
1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1
2	4	4	5	5	5	5	5	5	5	5	5	5	5	5	2
3	7	7	7	7	7	7	7	7	7	7	7	7	7	7	3
4	9	9	9	9	9	9	9	9	9	9	10	10	10	10	4
5	11	11	11	11	11	12	12	12	12	12	12	12	12	12	5
6	13	13	14	14	14	14	14	14	14	14	14	14	15	15	6
7	16	16	16	16	16	16	16	16	16	17	17	17	17	17	7
8	18	18	18	18	18	18	19	19	19	19	19	19	19	19	8
9	20	20	20	20	21	21	21	21	21	21	21	22	22	22	9
10	22	22	23	23	23	23	23	23	24	24	24	24	24	24	10
11	24	25	25	25	25	25	25	26	26	26	26	26	27	27	11
12	27	27	27	27	27	28	28	28	28	28	29	29	29	29	12
13	29	29	29	29	30	30	30	30	31	31	31	31	31	32	13
14	31	31	32	32	32	32	32	33	33	33	33	34	34	34	14
15	33	34	34	34	34	35	35	35	35	36	36	36	36	37	15
16	35	36	36	36	37	37	37	37	38	38	38	38	39	39	16
17	38	38	38	39	39	39	39	40	40	40	41	41	41	41	17
18	40	40	41	41	41	41	42	42	42	43	43	43	44	44	18
19	42	42	43	43	43	44	44	44	45	45	45	46	46	46	19
20	44	45	45	45	46	46	46	47	47	47	48	48	48	49	20
21	47	47	47	48	48	48	49	49	49	50	50	50	51	51	21
22	49	49	50	50	50	51	51	51	52	52	52	53	53	54	22
23	51	51	52	52	53	53	53	54	54	54	55	55	56	56	23
24	53	54	54	54	55	55	56	56	56	57	57	58	58	58	24
25	55	56	56	57	57	58	58	58	59	59	60	60	60	61	25
26	58	58	59	59	59	60	60	61	61	62	62	62	63	63	26
27	60	60	61	61	62	62	63	63	63	64	64	65	65	66	27
28	62	63	63	63	64	64	65	65	66	66	67	67	68	68	28
29	64	65	65	66	66	67	67	68	68	69	69	70	70	71	29
30	67	67	68	68	69	69	70	70	71	71	72	72	73	73	30
31	69	69	70	70	71	71	72	72	73	73	74	74	75	75	31
32	71	71	72	73	73	74	74	75	75	76	76	77	77	78	32
33	73	74	74	75	75	76	76	77	78	78	79	79	80	80	33
34	75	76	77	77	78	78	79	79	80	80	81	82	82	83	34
35	78	78	79	79	80	81	81	82	82	83	83	84	85	85	35
36	80	80	81	82	82	83	83	84	85	85	86	86	87	88	36
37	82	83	83	84	84	85	86	86	87	88	88	89	89	90	37
38	84	85	86	86	87	87	88	89	89	90	91	91	92	92	38
39	86	87	88	88	89	90	90	91	92	92	93	94	94	95	39
40	89	89	90	91	91	92	93	93	94	95	95	96	97	97	40
41	91	92	92	93	94	94	95	96	96	97	98	98	99	100	41
42	93	94	95	95	96	97	97	98	99	99	100	101	102	102	42
43	95	96	97	97	98	99	100	100	101	102	102	103	104	105	43
44	98	98	99	100	100	101	102	103	103	104	105	106	106	107	44
45	100	101	101	102	103	104	104	105	106	107	107	108	109	110	45
46	102	103	104	104	105	106	107	107	108	109	110	110	111	112	46
47	104	105	106	107	107	108	109	110	110	111	112	113	114	114	47
48	106	107	108	109	110	110	111	112	113	114	114	115	116	117	48
49	109	109	110	111	112	113	114	114	115	116	117	118	118	119	49
50	111	112	113	113	114	115	116	117	118	118	119	120	121	122	50
51	113	114	115	116	116	117	118	119	120	121	122	122	123	124	51
52	115	116	117	118	119	120	120	121	122	123	124	125	126	127	52
53	117	118	119	120	121	122	123	124	125	125	126	127	128	129	53
54	120	121	122	122	123	124	125	126	127	128	129	130	131	131	54
55	122	123	124	125	126	127	127	128	129	130	131	132	133	134	55
56	124	125	126	127	128	129	130	131	132	133	133	134	135	136	56
57	126	127	128	129	130	131	132	133	134	135	136	137	138	139	57
58	129	130	131	131	132	133	134	135	136	137	138	139	140	141	58
59	131	132	133	134	135	136	137	138	139	140	141	142	143	144	59
60	133	134	135	136	137	138	139	140	141	142	143	144	145	146	60

TABLE 12.

For finding the Variation of the Sun's Right Ascension, or Declination, or of the Equation of Time in any number of minutes of time, the Horary Motion being given at the top of the page in seconds, and the number of minutes of time in the side column. Also for finding the Variation of the Moon's Declination or Right Ascension in seconds of time, the motion in one minute being given at the top, and the numbers in the side column being taken for seconds.

M.	Horary motion.														M.
	147″	148″	149″	150″	151″	152″	153″	154″	155″	156″	157″	158″	159″	160″	
1	2	2	2	3	3	3	3	3	3	3	3	3	3	3	1
2	5	5	5	5	5	5	5	5	5	5	5	5	5	5	2
3	7	7	7	8	8	8	8	8	8	8	8	8	8	8	3
4	10	10	10	10	10	10	10	10	10	10	10	11	11	11	4
5	12	12	12	13	13	13	13	13	13	13	13	13	13	13	5
6	15	15	15	15	15	15	15	15	16	16	16	16	16	16	6
7	17	17	17	18	18	18	18	18	18	18	18	18	19	19	7
8	20	20	20	20	20	20	20	21	21	21	21	21	21	21	8
9	22	22	22	23	23	23	23	23	23	23	24	24	24	24	9
10	25	25	25	25	25	25	26	26	26	26	26	26	27	27	10
11	27	27	27	28	28	28	28	28	28	29	29	29	29	29	11
12	29	30	30	30	30	30	31	31	31	31	31	32	32	32	12
13	32	32	32	33	33	33	33	33	34	34	34	34	34	35	13
14	34	35	35	35	35	35	36	36	36	36	37	37	37	37	14
15	37	37	37	38	38	38	38	39	39	39	39	40	40	40	15
16	39	39	40	40	40	41	41	41	41	42	42	42	42	43	16
17	42	42	42	43	43	43	43	44	44	44	44	45	45	45	17
18	44	44	45	45	45	46	46	46	47	47	47	47	48	48	18
19	47	47	47	48	48	48	48	49	49	49	50	50	50	51	19
20	49	49	50	50	50	51	51	51	52	52	52	53	53	53	20
21	51	52	52	53	53	53	54	54	54	55	55	55	56	56	21
22	54	54	55	55	55	56	56	56	57	57	58	58	58	59	22
23	56	57	57	58	58	58	59	59	59	60	60	61	61	61	23
24	59	59	60	60	60	61	61	62	62	62	63	63	64	64	24
25	61	62	62	63	63	63	64	64	65	65	65	66	66	67	25
26	64	64	65	65	65	66	66	67	67	68	68	68	69	69	26
27	66	67	67	68	68	68	69	69	70	70	71	71	72	72	27
28	69	69	70	70	70	71	71	72	72	73	73	74	74	75	28
29	71	72	72	73	73	73	74	74	75	75	76	76	77	77	29
30	74	74	75	75	76	76	77	77	78	78	79	79	80	80	30
31	76	76	77	78	78	79	79	80	80	81	81	82	82	83	31
32	78	79	79	80	81	81	82	82	83	83	84	84	85	85	32
33	81	81	82	83	83	84	84	85	85	86	86	87	87	88	33
34	83	84	84	85	86	86	87	87	88	88	89	90	90	91	34
35	86	86	87	88	88	89	89	90	90	91	92	92	93	93	35
36	88	89	89	90	91	91	92	92	93	94	94	95	95	96	36
37	91	91	92	93	93	94	94	95	96	96	97	97	98	99	37
38	93	94	94	95	96	96	97	98	98	99	99	100	101	101	38
39	96	96	97	98	98	99	99	100	101	101	102	103	103	104	39
40	98	99	99	100	101	101	102	103	103	104	105	105	106	107	40
41	100	101	102	103	103	104	105	105	106	107	107	108	109	109	41
42	103	104	104	105	106	106	107	108	109	109	110	111	111	112	42
43	105	106	107	108	108	109	110	110	111	112	113	113	114	115	43
44	108	109	109	110	111	111	112	113	114	114	115	116	117	117	44
45	110	111	112	113	113	114	115	116	116	117	118	119	119	120	45
46	113	113	114	115	116	117	117	118	119	120	120	121	122	123	46
47	115	116	117	118	118	119	120	121	121	122	123	124	125	125	47
48	118	118	119	120	121	122	122	123	124	125	126	126	127	128	48
49	120	121	122	123	123	124	125	126	127	127	128	129	130	131	49
50	123	123	124	125	126	127	128	128	129	130	131	132	133	133	50
51	125	126	127	128	128	129	130	131	132	133	133	134	135	136	51
52	127	128	129	130	131	132	133	133	134	135	136	137	138	139	52
53	130	131	132	133	133	134	135	136	137	138	139	140	140	141	53
54	132	133	134	135	136	137	138	139	140	140	141	142	143	144	54
55	135	136	137	138	138	139	140	141	142	143	144	145	146	147	55
56	137	138	139	140	141	142	143	144	145	146	147	147	148	149	56
57	140	141	142	143	143	144	145	146	147	148	149	150	151	152	57
58	142	143	144	145	146	147	148	149	150	151	152	153	154	155	58
59	145	146	147	148	148	149	150	151	152	153	154	155	156	157	59
60	147	148	149	150	151	152	153	154	155	156	157	158	159	160	60

TABLE 13.

For finding the Sun's change of Right Ascension for any given number of hours.

Hourly variation.	Number of hours.												Hourly variation.
	1	2	3	4	5	6	7	8	9	10	11	12	
s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.
8.50	8.5	17.0	25.5	34.0	42.5	51.0	59.5	68.0	76.5	85.0	93.5	102.0	8.50
8.55	8.6	17.1	25.7	34.2	42.8	51.3	59.9	68.4	77.0	85.5	94.1	102.6	8.55
8.60	8.6	17.2	25.8	34.4	43.0	51.6	60.2	68.8	77.4	86.0	94.6	103.2	8.60
8.65	8.7	17.3	26.0	34.6	43.3	51.9	60.6	69.2	77.9	86.5	95.2	103.8	8.65
8.70	8.7	17.4	26.1	34.8	43.5	52.2	60.9	69.6	78.3	87.0	95.7	104.4	8.70
8.75	8.8	17.5	26.3	35.0	43.8	52.5	61.3	70.0	78.8	87.5	96.3	105.0	8.75
8.80	8.8	17.6	26.4	35.2	44.0	52.8	61.6	70.4	79.2	88.0	96.8	105.6	8.80
8.85	8.9	17.7	26.6	35.4	44.3	53.1	62.0	70.8	79.7	88.5	97.4	106.2	8.85
8.90	8.9	17.8	26.7	35.6	44.5	53.4	62.3	71.2	80.1	89.0	97.9	106.8	8.90
8.95	9.0	17.9	26.9	35.8	44.8	53.7	62.7	71.6	80.6	89.5	98.5	107.4	8.95
9.00	9.0	18.0	27.0	36.0	45.0	54.0	63.0	72.0	81.0	90.0	99.0	108.0	9.00
9.05	9.1	18.1	27.2	36.2	45.3	54.3	63.4	72.4	81.5	90.5	99.6	108.6	9.05
9.10	9.1	18.2	27.3	36.4	45.5	54.6	63.7	72.8	81.9	91.0	100.1	109.2	9.10
9.15	9.2	18.3	27.5	36.6	45.8	54.9	64.1	73.2	82.4	91.5	100.7	109.8	9.15
9.20	9.2	18.4	27.6	36.8	46.0	55.2	64.4	73.6	82.8	92.0	101.2	110.4	9.20
9.25	9.3	18.5	27.8	37.0	46.3	55.5	64.8	74.0	83.3	92.5	101.8	111.0	9.25
9.30	9.3	18.6	27.9	37.2	46.5	55.8	65.1	74.4	83.7	93.0	102.3	111.6	9.30
9.35	9.4	18.7	28.1	37.4	46.8	56.1	65.5	74.8	84.2	93.5	102.9	112.2	9.35
9.40	9.4	18.8	28.2	37.6	47.0	56.4	65.8	75.2	84.6	94.0	103.4	112.8	9.40
9.45	9.5	18.9	28.4	37.8	47.3	56.7	66.2	75.6	85.1	94.5	104.0	113.4	9.45
9.50	9.5	19.0	28.5	38.0	47.5	57.0	66.5	76.0	85.5	95.0	104.5	114.0	9.50
9.55	9.6	19.1	28.7	38.2	47.8	57.3	66.9	76.4	86.0	95.5	105.1	114.6	9.55
9.60	9.6	19.2	28.8	38.4	48.0	57.6	67.2	76.8	86.4	96.0	105.6	115.2	9.60
9.65	9.7	19.3	29.0	38.6	48.3	57.9	67.6	77.2	86.9	96.5	106.2	115.8	9.65
9.70	9.7	19.4	29.1	38.8	48.5	58.2	67.9	77.6	87.3	97.0	106.7	116.4	9.70
9.75	9.8	19.5	29.3	39.0	48.8	58.5	68.3	78.0	87.8	97.5	107.3	117.0	9.75
9.80	9.8	19.6	29.4	39.2	49.0	58.8	68.6	78.4	88.2	98.0	107.8	117.6	9.80
9.85	9.9	19.7	29.6	39.4	49.3	59.1	69.0	78.8	88.7	98.5	108.4	118.2	9.85
9.90	9.9	19.8	29.7	39.6	49.5	59.4	69.3	79.2	89.1	99.0	108.9	118.8	9.90
9.95	10.0	19.9	29.9	39.8	49.8	59.7	69.7	79.6	89.6	99.5	109.5	119.4	9.95
10.00	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	10.00
10.05	10.1	20.1	30.2	40.2	50.3	60.3	70.4	80.4	90.5	100.5	110.6	120.6	10.05
10.10	10.1	20.2	30.3	40.4	50.5	60.6	70.7	80.8	90.9	101.0	111.1	121.2	10.10
10.15	10.2	20.3	30.5	40.6	50.8	60.9	71.1	81.2	91.4	101.5	111.7	121.8	10.15
10.20	10.2	20.4	30.6	40.8	51.0	61.2	71.4	81.6	91.8	102.0	112.2	122.4	10.20
10.25	10.3	20.5	30.8	41.0	51.3	61.5	71.8	82.0	92.3	102.5	112.8	123.0	10.25
10.30	10.3	20.6	30.9	41.2	51.5	61.8	72.1	82.4	92.7	103.0	113.3	123.6	10.30
10.35	10.4	20.7	31.1	41.4	51.8	62.1	72.5	82.8	93.2	103.5	113.9	124.2	10.35
10.40	10.4	20.8	31.2	41.6	52.0	62.4	72.8	83.2	93.6	104.0	114.4	124.8	10.40
10.45	10.5	20.9	31.4	41.8	52.3	62.7	73.2	83.6	94.1	104.5	115.0	125.4	10.45
10.50	10.5	21.0	31.5	42.0	52.5	63.0	73.5	84.0	94.5	105.0	115.5	126.0	10.50
10.55	10.6	21.1	31.7	42.2	52.8	63.3	73.9	84.4	95.0	105.5	116.1	126.6	10.55
10.60	10.6	21.2	31.8	42.4	53.0	63.6	74.2	84.8	95.4	106.0	116.6	127.2	10.60
10.65	10.7	21.3	32.0	42.6	53.3	63.9	74.6	85.2	95.9	106.5	117.2	127.8	10.65
10.70	10.7	21.4	32.1	42.8	53.5	64.2	74.9	85.6	96.3	107.0	117.7	128.4	10.70
10.75	10.8	21.5	32.3	43.0	53.8	64.5	75.3	86.0	96.8	107.5	118.3	129.0	10.75
10.80	10.8	21.6	32.4	43.2	54.0	64.8	75.6	86.4	97.2	108.0	118.8	129.6	10.80
10.85	10.9	21.7	32.6	43.4	54.3	65.1	76.0	86.8	97.7	108.5	119.4	130.2	10.85
10.90	10.9	21.8	32.7	43.6	54.5	65.4	76.3	87.2	98.1	109.0	119.9	130.8	10.90
10.95	11.0	21.9	32.9	43.8	54.8	65.7	76.7	87.6	98.6	109.5	120.5	131.4	10.95
11.00	11.0	22.0	33.0	44.0	55.0	66.0	77.0	88.0	99.0	110.0	121.0	132.0	11.00
11.05	11.1	22.1	33.2	44.2	55.3	66.3	77.4	88.4	99.5	110.5	121.6	132.6	11.05
11.10	11.1	22.2	33.3	44.4	55.5	66.6	77.7	88.8	99.9	111.0	122.1	133.2	11.10
11.15	11.2	22.3	33.5	44.6	55.8	66.9	78.1	89.2	100.4	111.5	122.7	133.8	11.15
11.20	11.2	22.4	33.6	44.8	56.0	67.2	78.4	89.6	100.8	112.0	123.2	134.4	11.20
11.25	11.3	22.5	33.8	45.0	56.3	67.5	78.8	90.0	101.3	112.5	123.8	135.0	11.25
11.30	11.3	22.6	33.9	45.2	56.5	67.8	79.1	90.4	101.7	113.0	124.3	135.6	11.30
11.35	11.4	22.7	34.1	45.4	56.8	68.1	79.5	90.8	102.2	113.5	124.9	136.2	11.35
11.40	11.4	22.8	34.2	45.6	57.0	68.4	79.8	91.2	102.6	114.0	125.4	136.8	11.40
11.45	11.5	22.9	34.4	45.8	57.3	68.7	80.2	91.6	103.1	114.5	126.0	137.4	11.45

TABLE 13.

For finding the Sun's change of Right Ascension for any given number of hours.

Hourly variation.	Number of hours.												Hourly variation.
	13	14	15	16	17	18	19	20	21	22	23	24	
s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.
8.50	110.5	119.0	127.5	136.0	144.5	153.0	161.5	170.0	178.5	187.0	195.5	204.0	8.50
8.55	111.2	119.7	128.3	136.8	145.4	153.9	162.5	171.0	179.6	188.1	196.7	205.2	8.55
8.60	111.8	120.4	129.0	137.6	146.2	154.8	163.4	172.0	180.6	189.2	197.8	206.4	8.60
8.65	112.5	121.1	129.8	138.4	147.1	155.7	164.4	173.0	181.7	190.3	199.0	207.6	8.65
8.70	113.1	121.8	130.5	139.2	147.9	156.6	165.3	174.0	182.7	191.4	200.1	208.8	8.70
8.75	113.8	122.5	131.3	140.0	148.8	157.5	166.3	175.0	183.8	192.5	201.3	210.0	8.75
8.80	114.4	123.2	132.0	140.8	149.6	158.4	167.2	176.0	184.8	193.6	202.4	211.2	8.80
8.85	115.1	123.9	132.8	141.6	150.5	159.3	168.2	177.0	185.9	194.7	203.6	212.4	8.85
8.90	115.7	124.6	133.5	142.4	151.3	160.2	169.1	178.0	186.9	195.8	204.7	213.6	8.90
8.95	116.4	125.3	134.3	143.2	152.2	161.1	170.1	179.0	188.0	196.9	205.9	214.8	8.95
9.00	117.0	126.0	135.0	144.0	153.0	162.0	171.0	180.0	189.0	198.0	207.0	216.0	9.00
9.05	117.7	126.7	135.8	144.8	153.9	162.9	172.0	181.0	190.1	199.1	208.2	217.2	9.05
9.10	118.3	127.4	136.5	145.6	154.7	163.8	172.9	182.0	191.1	200.2	209.3	218.4	9.10
9.15	119.0	128.1	137.3	146.4	155.6	164.7	173.9	183.0	192.2	201.3	210.5	219.6	9.15
9.20	119.6	128.8	138.0	147.2	156.4	165.6	174.8	184.0	193.2	202.4	211.6	220.8	9.20
9.25	120.3	129.5	138.8	148.0	157.3	166.5	175.8	185.0	194.3	203.5	212.8	222.0	9.25
9.30	120.9	130.2	139.5	148.8	158.1	167.4	176.7	186.0	195.3	204.6	213.9	223.2	9.30
9.35	121.6	130.9	140.3	149.6	159.0	168.3	177.7	187.0	196.4	205.7	215.1	224.4	9.35
9.40	122.2	131.6	141.0	150.4	159.8	169.2	178.6	188.0	197.4	206.8	216.2	225.6	9.40
9.45	122.9	132.3	141.8	151.2	160.7	170.1	179.6	189.0	198.5	207.9	217.4	226.8	9.45
9.50	123.5	133.0	142.5	152.0	161.5	171.0	180.5	190.0	199.5	209.0	218.5	228.0	9.50
9.55	124.2	133.7	143.3	152.8	162.4	171.9	181.5	191.0	200.6	210.1	219.7	229.2	9.55
9.60	124.8	134.4	144.0	153.6	163.2	172.8	182.4	192.0	201.6	211.2	220.8	230.4	9.60
9.65	125.5	135.1	144.8	154.4	164.1	173.7	183.4	193.0	202.7	212.3	222.0	231.6	9.65
9.70	126.1	135.8	145.5	155.2	164.9	174.6	184.3	194.0	203.7	213.4	223.1	232.8	9.70
9.75	126.8	136.5	146.3	156.0	165.8	175.5	185.3	195.0	204.8	214.5	224.3	234.0	9.75
9.80	127.4	137.2	147.0	156.8	166.6	176.4	186.2	196.0	205.8	215.6	225.4	235.2	9.80
9.85	128.1	137.9	147.8	157.6	167.5	177.3	187.2	197.0	206.9	216.7	226.6	236.4	9.85
9.90	128.7	138.6	148.5	158.4	168.3	178.2	188.1	198.0	207.9	217.8	227.7	237.6	9.90
9.95	129.4	139.3	149.3	159.2	169.2	179.1	189.1	199.0	209.0	218.9	228.9	238.8	9.95
10.00	130.0	140.0	150.0	160.0	170.0	180.0	190.0	200.0	210.0	220.0	230.0	240.0	10.00
10.05	130.7	140.7	150.8	160.8	170.9	180.9	191.0	201.0	211.1	221.1	231.2	241.2	10.05
10.10	131.3	141.4	151.5	161.6	171.7	181.8	191.9	202.0	212.1	222.2	232.3	242.4	10.10
10.15	132.0	142.1	152.3	162.4	172.6	182.7	192.9	203.0	213.2	223.3	233.5	243.6	10.15
10.20	132.6	142.8	153.0	163.2	173.4	183.6	193.8	204.0	214.2	224.4	234.6	244.8	10.20
10.25	133.3	143.5	153.8	164.0	174.3	184.5	194.8	205.0	215.3	225.5	235.8	246.0	10.25
10.30	133.9	144.2	154.5	164.8	175.1	185.4	195.7	206.0	216.3	226.6	236.9	247.2	10.30
10.35	134.6	144.9	155.3	165.6	176.0	186.3	196.7	207.0	217.4	227.7	238.1	248.4	10.35
10.40	135.2	145.6	156.0	166.4	176.8	187.2	197.6	208.0	218.4	228.8	239.2	249.6	10.40
10.45	135.9	146.3	156.8	167.2	177.7	188.1	198.6	209.0	219.5	229.9	240.4	250.8	10.45
10.50	136.5	147.0	157.5	168.0	178.5	189.0	199.5	210.0	220.5	231.0	241.5	252.0	10.50
10.55	137.2	147.7	158.3	168.8	179.4	189.9	200.5	211.0	221.6	232.1	242.7	253.2	10.55
10.60	137.8	148.4	159.0	169.6	180.2	190.8	201.4	212.0	222.6	233.2	243.8	254.4	10.60
10.65	138.5	149.1	159.8	170.4	181.1	191.7	202.4	213.0	223.7	234.3	245.0	255.6	10.65
10.70	139.1	149.8	160.5	171.2	181.9	192.6	203.3	214.0	224.7	235.4	246.1	256.8	10.70
10.75	139.8	150.5	161.3	172.0	182.8	193.5	204.3	215.0	225.8	236.5	247.3	258.0	10.75
10.80	140.4	151.2	162.0	172.8	183.6	194.4	205.2	216.0	226.8	237.6	248.4	259.2	10.80
10.85	141.1	151.9	162.8	173.6	184.5	195.3	206.2	217.0	227.9	238.7	249.6	260.4	10.85
10.90	141.7	152.6	163.5	174.4	185.3	196.2	207.1	218.0	228.9	239.8	250.7	261.6	10.90
10.95	142.4	153.3	164.3	175.2	186.2	197.1	208.1	219.0	230.0	240.9	251.9	262.8	10.95
11.00	143.0	154.0	165.0	176.0	187.0	198.0	209.0	220.0	231.0	242.0	253.0	264.0	11.00
11.05	143.7	154.7	165.8	176.8	187.9	198.9	210.0	221.0	232.1	243.1	254.2	265.2	11.05
11.10	144.3	155.4	166.5	177.6	188.7	199.8	210.9	222.0	233.1	244.2	255.3	266.4	11.10
11.15	145.0	156.1	167.3	178.4	189.6	200.7	211.9	223.0	234.2	245.3	256.5	267.6	11.15
11.20	145.6	156.8	168.0	179.2	190.4	201.6	212.8	224.0	235.2	246.4	257.6	268.8	11.20
11.25	146.3	157.5	168.8	180.0	191.3	202.5	213.8	225.0	236.3	247.5	258.8	270.0	11.25
11.30	146.9	158.2	169.5	180.8	192.1	203.4	214.7	226.0	237.3	248.6	259.9	271.2	11.30
11.35	147.6	158.9	170.3	181.6	193.0	204.3	215.7	227.0	238.4	249.7	261.1	272.4	11.35
11.40	148.2	159.6	171.0	182.4	193.8	205.2	216.6	228.0	239.4	250.8	262.2	273.6	11.40
11.45	148.9	160.3	171.8	183.2	194.7	206.1	217.6	229.0	240.5	251.9	263.4	274.8	11.45

TABLE 14.

Dip of the Sea Horizon.

Height of the Eye.	Dip of the Horizon.
Feet.	′ ″
1	0 59
2	1 23
3	1 42
4	1 58
5	2 11
6	2 24
7	2 36
8	2 46
9	2 56
10	3 06
11	3 15
12	3 24
13	3 32
14	3 40
15	3 48
16	3 55
17	4 02
18	4 09
19	4 16
20	4 23
21	4 29
22	4 36
23	4 42
24	4 48
25	4 54
26	5 00
27	5 06
28	5 11
29	5 17
30	5 22
31	5 27
32	5 33
33	5 38
34	5 43
35	5 48
36	5 53
37	5 58
38	6 02
39	6 07
40	6 12
45	6 36
50	6 56
55	7 16
60	7 35
65	7 54
70	8 12
75	8 29
80	8 46
85	9 02
90	9 18
95	9 33
100	9 48

TABLE 15.

Dip of the Sea at different Distances from the Observer.

Dist. of Land in Sea Miles.	Height of the Eye above the Sea in Feet.							
	5	10	15	20	25	30	35	40
	′	′	′	′	′	′	′	′
¼	11	23	34	45	57	68	79	91
½	6	12	17	23	28	34	40	45
¾	4	8	12	15	19	23	27	30
1	3	6	9	12	15	17	20	23
1¼	3	5	7	10	12	14	16	19
1½	3	4	6	8	10	12	14	16
2	2	4	5	7	8	9	11	12
2½	2	3	4	6	7	8	9	10
3	2	3	4	5	6	7	8	9
3½	2	3	4	5	6	6	7	8
4	2	3	4	5	5	6	7	7
5	2	3	4	4	5	6	6	7
6	2	3	4	4	5	5	6	6

NOTE TO TABLE 15.—The numbers of this Table below the black lines are the same as are given in Table 14, the visible horizon corresponding to those heights not being so far distant as the land.

TABLE 16.

The Sun's Parallax in Altitude.

Altitude.	Parallax.
°	″
0	9
10	9
20	8
30	8
40	7
50	6
55	5
60	4
65	4
70	3
75	2
80	2
85	1
90	0

TABLE 17.

Parallax in Altitude of a Planet.

Altitude.	Horizontal parallax of planet.																														Altitude.
	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″	16″	17″	18″	19″	20″	21″	22″	23″	24″	25″	26″	27″	28″	30″	35″	
0°	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	30	35	0°
10	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	30	35	10
20	1	2	3	4	5	6	7	8	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	23	24	25	26	28	33	20
30	1	2	3	3	4	5	6	7	8	9	10	10	11	12	13	14	15	16	16	17	18	19	20	21	22	23	23	24	26	30	30
35	1	2	2	3	4	5	6	7	7	8	9	10	11	11	12	13	14	15	16	16	17	18	19	20	20	21	22	23	25	29	35
40	1	2	2	3	4	5	5	6	7	8	8	9	10	11	11	12	13	14	15	15	16	17	18	18	19	20	21	21	23	27	40
43	1	1	2	3	4	4	5	6	7	7	8	9	10	10	11	12	12	13	14	15	15	16	17	18	18	19	20	20	22	26	43
46	1	1	2	3	3	4	5	6	6	7	8	8	9	10	10	11	12	13	13	14	15	15	16	17	17	18	19	19	21	24	46
49	1	1	2	3	3	4	5	5	6	7	7	8	9	9	10	10	11	12	12	13	14	14	15	16	16	17	18	18	20	23	49
52	1	1	2	2	3	4	4	5	6	6	7	7	8	9	9	10	10	11	12	12	13	14	14	15	15	16	17	17	18	22	52
55	1	1	2	2	3	3	4	5	5	6	6	7	7	8	9	9	10	10	11	11	12	13	13	14	14	15	15	16	17	20	55
58	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	10	10	11	11	12	12	13	13	14	14	15	16	19	58
61	0	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	13	14	15	17	61
64	0	1	1	2	2	3	3	4	4	4	5	5	6	6	7	7	7	8	8	9	9	10	10	11	11	11	12	12	13	15	64
67	0	1	1	2	2	2	3	3	4	4	4	5	5	5	6	6	7	7	7	8	8	9	9	9	10	10	11	11	12	14	67
70	0	1	1	1	2	2	2	3	3	3	4	4	4	5	5	5	6	6	6	7	7	8	8	8	9	9	9	10	10	12	70
72	0	1	1	1	2	2	2	2	3	3	3	4	4	4	5	5	5	6	6	6	6	7	7	7	8	8	8	9	9	11	72
74	0	1	1	1	1	2	2	2	2	3	3	3	4	4	4	4	5	5	5	6	6	6	6	7	7	7	7	8	8	10	74
76	0	0	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	5	5	5	5	6	6	6	6	7	7	7	8	76
78	0	0	1	1	1	1	1	2	2	2	2	2	3	3	3	3	4	4	4	4	4	5	5	5	5	5	6	6	6	7	78
80	0	0	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4	4	4	5	5	5	5	6	80
82	0	0	0	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	4	4	4	4	5	82
84	0	0	0	0	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	84
86	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	86
88	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	88
90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	90

TABLE 18.

Augmentation of the Moon's Semidiameter.

Apparent altitude of ☽.	☽'s Semidiameter.					
	14'	15'		16'		17'
	30"	0"	30"	0"	30"	0"
°	"	"	"	"	"	"
0	0.1	0.1	0.1	0.1	0.2	0.2
2	0.6	0.6	0.7	0.7	0.8	0.8
4	1.0	1.1	1.2	1.3	1.4	1.5
6	1.5	1.6	1.7	1.9	2.0	2.1
8	2.0	2.1	2.3	2.4	2.6	2.7
10	2.4	2.6	2.8	3.0	3.2	3.4
12	2.9	3.1	3.3	3.6	3.8	4.0
14	3.4	3.6	3.9	4.1	4.4	4.7
16	3.8	4.1	4.4	4.7	5.0	5.3
18	4.3	4.6	4.9	5.2	5.6	5.9
20	4.7	5.1	5.4	5.8	6.1	6.5
22	5.2	5.5	5.9	6.3	6.7	7.1
24	5.6	6.0	6.4	6.8	7.3	7.7
26	6.0	6.5	6.9	7.4	7.8	8.3
28	6.5	6.9	7.4	7.9	8.4	8.9
30	6.9	7.3	7.9	8.4	8.9	9.5
32	7.3	7.8	8.3	8.9	9.4	10.0
34	7.7	8.2	8.8	9.4	10.0	10.6
36	8.1	8.6	9.2	9.8	10.5	11.1
38	8.4	9.0	9.7	10.3	10.9	11.6
40	8.8	9.4	10.1	10.7	11.4	12.1
42	9.2	9.8	10.5	11.2	11.9	12.6
44	9.5	10.2	10.9	11.6	12.3	13.1
46	9.8	10.5	11.3	12.0	12.8	13.6
48	10.2	10.9	11.6	12.4	13.2	14.0
50	10.5	11.2	12.0	12.8	13.6	14.4
52	10.8	11.5	12.3	13.1	14.0	14.9
54	11.1	11.8	12.7	13.5	14.4	15.3
56	11.3	12.1	13.0	13.8	14.7	15.6
58	11.6	12.4	13.3	14.1	15.1	16.0
60	11.8	12.7	13.5	14.4	15.4	16.3
62	12.1	12.9	13.8	14.7	15.7	16.6
64	12.3	13.2	14.1	15.0	16.0	16.9
66	12.5	13.4	14.3	15.2	16.2	17.2
68	12.7	13.6	14.5	15.5	16.5	17.5
70	12.9	13.8	14.7	15.7	16.7	17.7
72	13.0	13.9	14.9	15.9	16.9	17.9
74	13.1	14.1	15.0	16.0	17.1	18.1
76	13.3	14.2	15.2	16.2	17.2	18.3
78	13.4	14.3	15.3	16.3	17.4	18.4
80	13.5	14.4	15.4	16.4	17.5	18.6
82	13.5	14.5	15.5	16.5	17.6	18.7
84	13.6	14.6	15.6	16.6	17.6	18.7
86	13.6	14.6	15.6	16.6	17.7	18.8
88	13.7	14.6	15.6	16.7	17.7	18.8
90	13.7	14.6	15.6	16.7	17.7	18.8

TABLE 19.

Augmentation of the Moon's Horizontal Parallax.

Latitude of observation.	☽'s Hor. Parallax.		
	53'	57'	61'
°	"	"	"
0	0.0	0.0	0.0
2	0.0	0.0	0.0
4	0.1	0.1	0.1
6	0.1	0.1	0.1
8	0.2	0.2	0.2
10	0.3	0.3	0.4
12	0.5	0.5	0.5
14	0.6	0.7	0.7
16	0.8	0.9	0.9
18	1.0	1.1	1.1
20	1.2	1.3	1.4
22	1.5	1.6	1.7
24	1.7	1.9	2.0
26	2.0	2.2	2.3
28	2.3	2.5	2.6
30	2.6	2.8	3.0
32	2.9	3.1	3.4
34	3.3	3.5	3.8
36	3.6	3.9	4.1
38	4.0	4.3	4.6
40	4.3	4.6	5.0
42	4.7	5.0	5.4
44	5.0	5.4	5.8
46	5.4	5.8	6.2
48	5.8	6.2	6.6
50	6.1	6.6	7.1
52	6.5	7.0	7.5
54	6.8	7.4	7.9
56	7.2	7.7	8.3
58	7.5	8.1	8.6
60	7.8	8.4	9.0
62	8.1	8.8	9.4
64	8.4	9.1	9.7
66	8.7	9.4	10.0
68	9.0	9.7	10.3
70	9.2	9.9	10.6
72	9.5	10.2	10.9
74	9.7	10.4	11.1
76	9.8	10.6	11.3
78	10.0	10.8	11.5
80	10.1	10.9	11.7
82	10.3	11.0	11.8
84	10.3	11.1	11.9
86	10.4	11.2	12.0
88	10.4	11.2	12.0
90	10.5	11.3	12.0

TABLE 20A.

Mean Refraction.

[Barometer, 30 inches. Fahrenheit's Thermometer, 50°.]

Apparent Altitude.	Mean Refraction.	Apparent Altitude.	Mean Refraction.	Apparent Altitude.	Mean Refraction.	Apparent Altitude.	Mean Refraction.	Apparent Altitude.	Mean Refraction.
° ′	′ ″	° ′	′ ″	° ′	′ ″	° ′	′ ″	° ′	′ ″
		9 30	5 35.1	15 00	3 34.1	25 00	2 4.4	42 00	1 04.7
0 00	36 29.4	35	5 32.4	10	3 31.7	10	2 3.4	20	1 03.9
1 00	24 53.6	40	5 29.6	20	3 29.4	20	2 2.5	40	1 03.2
2 00	18 25.5	45	5 27.0	30	3 27.1	30	2 1.6	43 00	1 02.4
3 00	14 25.1	50	5 24.3	40	3 24.8	40	2 0.7	20	1 01.7
4 00	11 44.4	55	5 21.7	50	3 22.6	50	1 59.8	40	1 01.0
5 00	9 52.0	10 00	5 19.2	16 00	3 20.5	26 00	1 58.9	44 00	1 00.3
05	9 44.0	05	5 16.7	10	3 18.4	10	1 58.1	20	0 59.6
10	9 36.2	10	5 14.2	20	3 16.3	20	1 57.2	40	0 58.9
15	9 28.6	15	5 11.7	30	3 14.2	30	1 56.4	45 00	0 58.2
20	9 21.2	20	5 9.3	40	3 12.2	40	1 55.5	20	0 57.6
25	9 14.0	25	5 6.9	50	3 10.3	50	1 54.7	40	0 56.9
5 30	9 7.0	10 30	5 4.6	17 00	3 8.3	27 00	1 53.9	46 00	0 56.2
35	9 0.1	35	5 2.3	10	3 6.4	10	1 53.1	20	0 55.6
40	8 53.4	40	5 0.0	20	3 4.6	20	1 52.3	40	0 55.0
45	8 46.8	45	4 57.8	30	3 2.8	30	1 51.5	47 00	0 54.3
50	8 40.4	50	4 55.6	40	3 1.0	40	1 50.7	20	0 53.7
55	8 34.2	55	4 53.4	50	2 59.2	50	1 50.0	40	0 53.1
6 00	8 28.0	11 00	4 51.2	18 00	2 57.5	28 00	1 49.2	48 00	0 52.5
05	8 22.1	05	4 49.1	10	2 55.8	20	1 47.7	49 00	0 50.6
10	8 16.2	10	4 47.0	20	2 54.1	40	1 46.2	50 00	0 48.9
15	8 10.5	15	4 44.9	30	2 52.4	29 00	1 44.8	51 00	0 47.2
20	8 4.8	20	4 42.9	40	2 50.8	20	1 43.4	52 00	0 45.5
25	7 59.3	25	4 40.9	50	2 49.2	40	1 42.0	53 00	0 43.9
6 30	7 53.9	11 30	4 38.9	19 00	2 47.7	30 00	1 40.6	54 00	0 42.3
35	7 48.7	35	4 36.9	10	2 46.1	20	1 39.3	55 00	0 40.8
40	7 43.5	40	4 35.0	20	2 44.6	40	1 38.0	56 00	0 39.3
45	7 38.4	45	4 33.1	30	2 43.1	31 00	1 36.7	57 00	0 37.8
50	7 33.5	50	4 31.2	40	2 41.6	20	1 35.5	58 00	0 36.4
55	7 28.6	55	4 29.4	50	2 40.2	40	1 34.2	59 00	0 35.0
7 00	7 23.8	12 00	4 27.5	20 00	2 38.8	32 00	1 33.0	60 00	0 33.6
05	7 19.2	05	4 25.7	10	2 37.4	20	1 31.8	61 00	0 32.3
10	7 14.6	10	4 23.9	20	2 36.0	40	1 30.7	62 00	0 31.0
15	7 10.1	15	4 22.2	30	2 34.6	33 00	1 29.5	63 00	0 29.7
20	7 5.7	20	4 20.4	40	2 33.3	20	1 28.4	64 00	0 28.4
25	7 1.4	25	4 18.7	50	2 32.0	40	1 27.3	65 00	0 27.2
7 30	6 57.1	12 30	4 17.0	21 00	2 30.7	34 00	1 26.2	66 00	0 25.9
35	6 53.0	35	4 15.3	10	2 29.4	20	1 25.1	67 00	0 24.7
40	6 48.9	40	4 13.6	20	2 28.1	40	1 24.1	68 00	0 23.6
45	6 44.9	45	4 12.0	30	2 26.9	35 00	1 23.1	69 00	0 22.4
50	6 41.0	50	4 10.4	40	2 25.7	20	1 22.0	70 00	0 21.2
55	6 37.1	55	4 8.8	50	2 24.5	40	1 21.0	71 00	0 20.1
8 00	6 33.3	13 00	4 7.2	22 00	2 23.3	36 00	1 20.1	72 00	0 18.9
05	6 29.6	05	4 5.6	10	2 22.1	20	1 19.1	73 00	0 17.8
10	6 25.9	10	4 4.1	20	2 20.9	40	1 18.2	74 00	0 16.7
15	6 22.3	15	4 2.6	30	2 19.8	37 00	1 17.2	75 00	0 15.6
20	6 18.8	20	4 1.0	40	2 18.7	20	1 16.3	76 00	0 14.5
25	6 15.3	25	3 59.6	50	2 17.5	40	1 15.4	77 00	0 13.5
8 30	6 11.9	13 30	3 58.1	23 00	2 16.4	38 00	1 14.5	78 00	0 12.4
35	6 8.5	35	3 56.6	10	2 15.4	20	1 13.6	79 00	0 11.3
40	6 5.2	40	3 55.2	20	2 14.3	40	[illegible]	80 00	0 10.3
45	6 2.0	45	3 53.7	30	2 13.3	39 00	[illegible]	81 00	0 9.2
50	5 58.8	50	3 52.3	40	2 12.2	20	[illegible]	82 00	0 8.2
55	5 55.7	55	3 50.9	50	2 11.2	40	[illegible]	83 00	0 7.2
9 00	5 52.6	14 00	3 49.5	24 00	2 10.2	40 00	1 9.4	84 00	0 6.1
05	5 49.6	10	3 46.8	10	2 9.2	20	1 8.6	85 00	0 5.1
10	5 46.6	20	3 44.2	20	2 8.2	40	1 7.8	86 00	0 4.1
15	5 43.6	30	3 41.6	30	2 7.2	41 00	1 7.0	87 00	0 3.1
20	5 40.7	40	3 39.0	40	2 6.2	20	1 6.2	88 00	0 2.0
25	5 37.9	50	3 36.5	50	2 5.3	40	1 5.4	89 00	0 1.0
9 30	5 35.1	15 00	3 34.1	25 00	2 4.4	42 00	1 4.[illegible]	90 00	0 0.0

TABLE 20B.

Correction of the Sun's Apparent Altitude for Refraction and Parallax.

[Barometer, 30 inches. Fahrenheit's Thermometer, 50°.]

Apparent Altitude.	Mean Refraction and Parallax ⊙.	Apparent Altitude.	Mean Refraction and Parallax ⊙.	Apparent Altitude.	Mean Refraction and Parallax ⊙.	Apparent Altitude.	Mean Refraction and Parallax ⊙.	Apparent Altitude.	Mean Refraction an Parallax ⊙
° ′	′ ″	° ′	′ ″	° ′	′ ″	° ′	′ ″	° ′	′ ″
		9 30	5 26	15 00	3 25	25 00	1 56	42 00	0 58
0 00	36 20	35	5 23	10	3 24	10	1 55	20	0 57
1 00	24 45	40	5 21	20	3 21	20	1 55	40	0 56
2 00	18 17	45	5 18	30	3 19	30	1 54	43 00	0 55
3 00	14 16	50	5 15	40	3 17	40	1 53	20	0 55
4 00	11 35	55	5 13	50	3 15	50	1 52	40	0 54
5 00	9 43	10 00	5 10	16 00	3 13	26 00	1 51	44 00	0 53
05	9 35	05	5 8	10	3 10	10	1 50	20	0 53
10	9 27	10	5 5	20	3 8	20	1 49	40	0 52
15	9 20	15	5 3	30	3 6	30	1 48	45 00	0 52
20	9 12	20	5 0	40	3 4	40	1 48	20	0 52
25	9 5	25	4 58	50	3 2	50	1 47	40	0 51
5 30	8 58	10 30	4 56	17 00	3 0	27 00	1 46	46 00	0 50
35	8 51	35	4 53	10	2 58	10	1 45	20	0 50
40	8 44	40	4 51	20	2 57	20	1 44	40	0 49
45	8 38	45	4 49	30	2 55	30	1 44	47 00	0 48
50	8 31	50	4 47	40	2 53	40	1 43	20	0 48
55	8 25	55	4 44	50	2 51	50	1 42	40	0 47
6 00	8 19	11 00	4 42	18 00	2 50	28 00	1 41	48 00	0 47
05	8 13	05	4 40	10	2 48	20	1 40	49 00	0 45
10	8 7	10	4 38	20	2 46	40	1 38	50 00	0 43
15	8 2	15	4 36	30	2 44	29 00	1 37	51 00	0 41
20	7 56	20	4 34	40	2 43	20	1 35	52 00	0 40
25	7 50	25	4 32	50	2 41	40	1 34	53 00	0 39
6 30	7 45	11 30	4 30	19 00	2 40	30 00	1 33	54 00	0 37
35	7 40	35	4 28	10	2 38	20	1 31	55 00	0 36
40	7 35	40	4 26	20	2 37	40	1 30	56 00	0 34
45	7 29	45	4 24	30	2 35	31 00	1 29	57 00	0 33
50	7 25	50	4 22	40	2 34	20	1 28	58 00	0 32
55	7 20	55	4 20	50	2 32	40	1 26	59 00	0 31
7 00	7 15	12 00	4 19	20 00	2 31	32 00	1 25	60 00	0 30
05	7 10	05	4 17	10	2 29	20	1 24	61 00	0 28
10	7 6	10	4 15	20	2 28	40	1 23	62 00	0 27
15	7 1	15	4 13	30	2 27	33 00	1 22	63 00	0 26
20	6 57	20	4 11	40	2 25	20	1 20	64 00	0 24
25	6 52	25	4 10	50	2 24	40	1 19	65 00	0 23
7 30	6 48	12 30	4 8	21 00	2 23	34 00	1 18	66 00	0 22
35	6 44	35	4 6	10	2 21	20	1 17	67 00	0 21
40	6 40	40	4 5	20	2 20	40	1 16	68 00	0 21
45	6 36	45	4 3	30	2 19	35 00	1 15	69 00	0 19
50	6 32	50	4 1	40	2 18	20	1 15	70 00	0 18
55	6 28	55	4 0	50	2 17	40	1 14	71 00	0 17
8 00	6 24	13 00	3 58	22 00	2 15	36 00	1 13	72 00	0 16
05	6 21	05	3 57	10	2 14	20	1 12	73 00	0 16
10	6 17	10	3 55	20	2 13	40	1 11	74 00	0 15
15	6 13	15	3 54	30	2 12	37 00	1 10	75 00	0 14
20	6 10	20	3 52	40	2 11	20	1 9	76 00	0 13
25	6 6	25	3 51	50	2 10	40	1 8	77 00	0 12
8 30	6 3	13 30	3 49	23 00	2 8	38 00	1 8	78 00	0 10
35	6 0	35	3 48	10	2 7	20	1 7	79 00	0 9
40	5 56	40	3 46	20	2 6	40	1 6	80 00	0 8
45	5 53	45	3 45	30	2 5	39 00	1 5	81 00	0 7
50	5 50	50	3 43	40	2 4	20	1 4	82 00	0 6
55	5 47	55	3 42	50	2 3	40	1 3	83 00	0 6
9 00	5 44	14 00	3 41	24 00	2 2	40 00	1 2	84 00	0 5
05	5 41	10	3 38	10	2 1	20	1 2	85 00	0 4
10	5 38	20	3 35	20	2 0	40	1 1	86 00	0 3
15	5 35	30	3 33	30	1 59	41 00	1 0	87 00	0 2
20	5 32	40	3 30	40	1 58	20	0 59	88 00	0 2
25	5 29	50	3 28	50	1 57	40	0 58	89 00	0 1
9 30	5 26	15 00	3 25	25 00	1 56	42 00	0 58	90 00	0 0

TABLE 21.

Correction of the Mean Refraction for the Height of the Barometer.

Barom. ubtract.	Mean refraction. 0′		1′		2′		3′		4′		5′		6′		7′		8′		9′		10′	Barom. Add.
	0″	30″	0″	30″	0″	30″	0″	30″	0″	30″	0″	30″	0″	30″	0″	30″	0″	30″	0″	30″	0″	
	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	
27.50	0	2	5	7	10	12	15	17	20	23	25	28	30	33	35	38	40	43	45	48	51	
27.55	0	2	5	7	10	12	15	17	20	22	25	27	30	32	35	37	40	42	45	47	50	
27.60	0	2	5	7	10	12	14	17	19	22	24	27	29	31	34	36	39	41	44	46	49	
27.65	0	2	5	7	9	12	14	16	19	21	24	26	28	31	33	36	38	40	43	45	48	
27.70	0	2	5	7	9	11	14	16	18	21	23	25	28	30	32	35	37	39	42	44	47	
27.75	0	2	4	7	9	11	13	16	18	20	23	25	27	29	32	34	36	39	41	43	46	
27.80	0	2	4	7	9	11	13	15	18	20	22	24	27	29	31	33	35	38	40	42	45	
27.85	0	2	4	6	9	11	13	15	17	19	22	24	26	28	30	32	35	37	39	41	44	
27.90	0	2	4	6	8	10	13	15	17	19	21	23	25	27	30	32	34	36	38	40	43	
27.95	0	2	4	6	8	10	12	14	16	18	21	23	25	27	29	31	33	35	37	39	42	
28.00	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	41	
28.05	0	2	4	6	8	10	12	14	16	18	20	22	24	25	27	29	31	33	35	37	39	
28.10	0	2	4	6	8	9	11	13	15	17	19	21	23	25	27	29	31	33	34	36	38	
28.15	0	2	4	6	7	9	11	13	15	17	19	20	22	24	26	28	30	32	34	36	37	
28.20	0	2	4	5	7	9	11	13	14	16	18	20	22	24	25	27	29	31	33	35	36	
28.25	0	2	3	5	7	9	10	12	14	16	18	19	21	23	25	26	28	30	32	34	35	
28.30	0	2	3	5	7	8	10	12	14	15	17	19	21	22	24	26	27	29	31	33	34	
28.35	0	2	3	5	7	8	10	12	13	15	17	18	20	22	23	25	27	28	30	32	33	
28.40	0	2	3	5	6	8	10	11	13	14	16	18	19	21	23	24	26	27	29	31	32	
28.45	0	2	3	5	6	8	9	11	12	14	16	17	19	20	22	23	25	27	28	30	31	
28.50	0	1	3	4	6	7	9	10	12	14	15	17	18	20	21	23	24	26	27	29	30	31.50
28.55	0	1	3	4	6	7	9	10	12	13	15	16	17	19	20	22	23	25	26	28	29	31.45
28.60	0	1	3	4	6	7	8	10	11	13	14	15	17	18	20	21	23	24	25	27	28	31.40
28.65	0	1	3	4	5	7	8	9	11	12	14	15	16	18	19	20	22	23	25	26	27	31.35
28.70	0	1	3	4	5	6	8	9	10	12	13	14	16	17	18	20	21	22	24	25	26	31.30
28.75	0	1	2	4	5	6	7	9	10	11	13	14	15	16	18	19	20	21	23	24	25	31.25
28.80	0	1	2	4	5	6	7	8	10	11	12	13	14	16	17	18	19	21	22	23	24	31.20
28.85	0	1	2	3	5	6	7	8	9	10	12	13	14	15	16	17	19	20	21	22	23	31.15
28.90	0	1	2	3	4	5	7	8	9	10	11	12	13	14	16	17	18	19	20	21	22	31.10
28.95	0	1	2	3	4	5	6	7	8	9	11	12	13	14	15	16	17	18	19	20	21	31.05
29.00	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	31.00
29.05	0	1	2	3	4	5	6	7	8	9	10	11	11	12	13	14	15	16	17	18	19	30.95
29.10	0	1	2	3	4	4	5	6	7	8	9	10	11	12	13	14	15	15	16	17	18	30.90
29.15	0	1	2	3	3	4	5	6	7	8	9	9	10	11	12	13	14	15	15	16	17	30.85
29.20	0	1	2	2	3	4	5	6	6	7	8	9	10	10	11	12	13	14	15	15	16	30.80
29.25	0	1	1	2	3	4	4	5	6	7	8	8	9	10	11	11	12	13	14	14	15	30.75
29.30	0	1	1	2	3	3	4	5	6	6	7	8	8	9	10	11	11	12	13	13	14	30.70
29.35	0	1	1	2	3	3	4	5	5	6	7	7	8	9	9	10	10	11	12	13	13	30.65
29.40	0	1	1	2	2	3	4	4	5	5	6	7	7	8	8	9	10	10	11	12	12	30.60
29.45	0	1	1	2	2	3	3	4	4	5	6	6	7	7	8	8	9	9	10	11	11	30.55
29.50	0	0	1	1	2	2	3	3	4	5	5	6	6	7	7	8	8	9	9	10	10	30.50
29.55	0	0	1	1	2	2	3	3	4	4	5	5	5	6	6	7	7	8	8	9	9	30.45
29.60	0	0	1	1	2	2	2	3	3	4	4	4	5	5	6	6	6	7	7	8	8	30.40
29.65	0	0	1	1	1	2	2	2	3	3	4	4	4	5	5	5	6	6	6	7	7	30.35
29.70	0	0	1	1	1	1	2	2	2	3	3	3	4	4	4	5	5	5	5	6	6	30.30
29.75	0	0	0	1	1	1	1	2	2	2	3	3	3	3	4	4	4	4	5	5	5	30.25
29.80	0	0	0	1	1	1	1	1	2	2	2	2	2	3	3	3	3	3	4	4	4	30.20
29.85	0	0	0	0	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	30.15
29.90	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	30.10
29.95	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	30.05
30.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30.00
ubtract.	0″	30″	0″	30″	0″	30″	0″	30″	0″	30″	0″	30″	0″	30″	0″	30″	0″	30″	0″	30″	0″	Add.
Barom.	0′		1′		2′		3′		4′		5′		6′		7′		8′		9′		10′	Barom.
	Mean refraction.																					

TABLE 22.

Correction of the Mean Refraction for the Height of the Thermometer.

Ther.	Mean refraction.																					Ther.
Add.	0′		1′		2′		3′		4′		5′		6′		7′		8′		9′		10′	Add.
	0″	30″	0″	30″	0″	30″	0″	30″	0″	30″	0″	30″	0′	30″	0″	30″	0″	30″	0″	30″	0″	
°	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	°
−10	0	4	8	12	16	20	24	28	33	37	41	46	50	55	60	65	70	75	80	85	90	−10
− 8	0	4	8	12	15	19	23	27	31	36	40	44	48	53	58	62	67	72	77	82	87	− 8
− 6	0	4	7	11	15	19	22	26	30	34	38	42	47	51	55	60	64	69	74	79	84	− 6
− 4	0	4	7	11	14	18	22	25	29	33	37	41	45	49	53	57	62	66	71	76	80	− 4
− 2	0	3	7	10	14	17	21	24	28	31	35	39	43	47	51	55	59	64	68	72	77	− 2
0	0	3	7	10	13	16	20	23	27	30	34	37	41	45	49	53	57	61	65	69	74	0
2	0	3	6	9	12	16	19	22	25	29	32	36	39	43	47	50	54	58	62	66	70	2
4	0	3	6	9	12	15	18	21	24	28	31	34	37	41	44	48	52	55	59	63	67	4
6	0	3	6	8	11	14	17	20	23	26	29	32	36	39	42	46	49	53	56	60	64	6
8	0	3	5	8	11	14	16	19	22	25	28	31	34	37	40	43	47	50	54	57	61	8
10	0	3	5	8	10	13	15	18	21	24	26	29	32	35	38	41	44	48	51	54	58	10
11	0	2	5	7	10	13	15	18	20	23	26	28	31	34	37	40	43	46	49	53	56	11
12	0	2	5	7	10	12	15	17	20	22	25	28	30	33	36	39	42	45	48	51	54	12
13	0	2	5	7	9	12	14	17	19	22	24	27	30	32	35	38	41	44	47	50	53	13
14	0	2	5	7	9	11	14	16	19	21	24	26	29	31	34	37	40	42	45	48	51	14
15	0	2	4	7	9	11	13	16	18	20	23	25	28	30	33	36	38	41	44	47	50	15
16	0	2	4	6	9	11	13	15	18	20	22	25	27	29	32	35	37	40	43	45	48	16
17	0	2	4	6	8	10	13	15	17	19	21	24	26	29	31	33	36	39	41	44	47	17
18	0	2	4	6	8	10	12	14	16	19	21	23	25	28	30	32	35	37	40	43	45	18
19	0	2	4	6	8	10	12	14	16	18	20	22	24	27	29	31	34	36	39	41	44	19
20	0	2	4	6	8	9	11	13	15	17	19	22	24	26	28	30	33	35	37	40	42	20
21	0	2	4	5	7	9	11	13	15	17	19	21	23	25	27	29	31	34	36	38	41	21
22	0	2	3	5	7	9	11	12	14	16	18	20	22	24	26	28	30	32	35	37	39	22
23	0	2	3	5	7	8	10	12	14	15	17	19	21	23	25	27	29	31	33	36	38	23
24	0	2	3	5	6	8	10	11	13	15	17	18	20	22	24	26	28	30	32	34	36	24
25	0	2	3	5	6	8	9	11	13	14	16	18	19	21	23	25	27	29	31	33	35	25
26	0	1	3	4	6	7	9	11	12	14	15	17	19	20	22	24	26	28	29	31	33	26
27	0	1	3	4	6	7	9	10	12	13	15	16	18	19	21	23	25	26	28	30	32	27
28	0	1	3	4	5	7	8	10	11	12	14	15	17	19	20	22	23	25	27	29	30	28
29	0	1	3	4	5	6	8	9	11	12	13	15	16	18	19	21	22	24	26	27	29	29
30	0	1	2	4	5	6	7	9	10	11	13	14	15	17	18	20	21	23	24	26	28	30
31	0	1	2	3	5	6	7	8	9	11	12	13	15	16	17	19	20	22	23	25	26	31
32	0	1	2	3	4	6	7	8	9	10	11	13	14	15	16	18	19	20	22	23	25	32
33	0	1	2	3	4	5	6	7	8	10	11	12	13	14	15	17	18	19	21	22	23	33
34	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	16	17	18	19	21	22	34
35	0	1	2	3	4	5	6	6	7	8	9	10	11	13	14	15	16	17	18	19	20	35
36	0	1	2	3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	36
37	0	1	2	2	3	4	5	6	6	7	8	9	10	11	12	13	14	15	16	17	18	37
38	0	1	1	2	3	4	4	5	6	7	7	8	9	10	11	12	13	13	14	15	16	38
39	0	1	1	2	3	3	4	5	5	6	7	8	8	9	10	11	11	12	13	14	15	39
40	0	1	1	2	2	3	4	4	5	6	6	7	8	8	9	10	10	11	12	13	13	40
41	0	1	1	2	2	3	3	4	4	5	6	6	7	7	8	9	9	10	11	11	12	41
42	0	0	1	1	2	2	3	3	4	4	5	5	6	7	7	8	8	9	9	10	11	42
43	0	0	1	1	2	2	3	3	3	4	4	5	5	6	6	7	7	8	8	9	9	43
44	0	0	1	1	1	2	2	3	3	3	4	4	4	5	5	6	6	7	7	8	8	44
45	0	0	1	1	1	1	2	2	2	3	3	3	4	4	4	5	5	6	6	6	7	45
46	0	0	0	1	1	1	1	2	2	2	2	2	3	3	4	4	4	4	5	5	5	46
47	0	0	0	1	1	1	1	1	1	2	2	2	2	2	3	3	3	3	4	4	4	47
48	0	0	0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	48
49	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	49
50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50
Add.	0″	30″	0″	30″	0″	30″	0″	30″	0″	30″	0″	30″	0″	30″	0″	30″	0″	30″	0″	30″	0″	Add.
	0′		1′		2′		3′		4′		5′		6′		7′		8′		9′		10′	
Ther.	Mean refraction.																					Ther.

TABLE 22.

Correction of the Mean Refraction for the Height of the Thermometer.

Ther.	Mean refraction.																					Ther.
Subt.	0'		1'		2'		3'		4'		5'		6'		7'		8'		9'		10'	Subt.
	0"	30"	0"	30"	0"	30"	0"	30"	0"	30"	0"	30"	0"	30"	0"	30"	0"	30"	0"	30"	0"	
°	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	°
50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50
51	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	51
52	0	0	0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	52
53	0	0	0	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	4	4	53
54	0	0	0	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	5	5	5	54
55	0	0	1	1	1	1	2	2	2	3	3	3	4	4	4	5	5	5	6	6	6	55
56	0	0	1	1	1	2	2	2	3	3	4	4	4	5	5	6	6	6	7	7	8	56
57	0	0	1	1	2	2	2	3	3	4	4	5	5	6	6	6	7	8	8	8	9	57
58	0	0	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	9	9	10	10	58
59	0	1	1	2	2	3	3	4	4	5	5	6	6	7	8	8	9	10	10	11	12	59
60	0	1	1	2	2	3	3	4	5	5	6	7	7	8	9	9	10	11	11	12	13	60
61	0	1	1	2	3	3	4	4	5	6	7	7	8	9	9	10	11	12	12	13	14	61
62	0	1	1	2	3	3	4	5	6	6	7	8	9	9	10	11	12	13	14	15	15	62
63	0	1	1	2	3	4	5	5	6	7	8	8	9	10	11	12	13	14	15	16	17	63
64	0	1	2	2	3	4	5	6	7	7	8	9	10	11	12	13	14	15	16	17	18	64
65	0	1	2	3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	65
66	0	1	2	3	4	5	6	6	7	8	9	10	11	12	14	15	16	17	18	19	20	66
67	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	16	17	18	19	20	22	67
68	0	1	2	3	4	5	6	7	8	9	11	11	13	14	15	16	18	19	20	22	23	68
69	0	1	2	3	4	5	7	8	9	10	11	12	13	15	16	17	19	20	21	23	24	69
70	0	1	2	3	5	6	7	8	9	10	12	12	14	16	17	18	20	21	22	24	25	70
71	0	1	2	4	5	6	7	8	10	11	12	13	15	16	18	19	20	22	23	25	27	71
72	0	1	2	4	5	6	8	9	10	11	13	14	16	17	18	20	21	23	25	26	28	72
73	0	1	3	4	5	7	8	9	11	12	13	14	16	18	19	21	22	24	26	27	29	73
74	0	1	3	4	5	7	8	10	11	12	14	15	17	18	20	22	23	25	27	28	30	74
75	0	1	3	4	6	7	8	10	11	13	14	16	18	19	21	22	24	26	28	29	31	75
76	0	1	3	4	6	7	9	10	12	13	15	16	18	20	22	23	25	27	29	31	32	76
77	0	1	3	5	6	8	9	11	12	14	16	17	19	21	22	24	26	28	30	32	34	77
78	0	2	3	5	6	8	9	11	13	14	16	18	20	21	23	25	27	29	31	33	35	78
79	0	2	3	5	6	8	10	11	13	15	17	18	20	22	24	26	28	30	32	34	36	79
80	0	2	3	5	7	8	10	12	14	15	17	19	21	23	25	27	29	31	33	35	37	80
81	0	2	3	5	7	9	10	12	14	16	18	20	21	24	26	28	30	32	34	36	38	81
82	0	2	4	5	7	9	11	13	14	16	18	20	22	24	26	28	31	33	35	37	40	82
83	0	2	4	5	7	9	11	13	15	17	19	21	23	25	27	29	31	34	36	38	41	83
84	0	2	4	6	8	9	11	13	15	17	19	21	23	26	28	30	32	35	37	39	42	84
85	0	2	4	6	8	10	12	14	16	18	20	22	24	26	29	31	33	36	38	40	43	85
86	0	2	4	6	8	10	12	14	16	18	20	23	25	27	29	32	34	37	39	42	44	86
87	0	2	4	6	8	10	12	14	17	19	21	23	25	28	30	32	35	38	40	43	45	87
88	0	2	4	6	8	10	13	15	17	19	21	24	26	28	31	33	36	38	41	44	46	88
89	0	2	4	6	9	11	13	15	17	20	22	24	27	29	32	34	37	39	42	45	48	89
90	0	2	4	7	9	11	13	16	18	20	23	25	27	30	32	35	38	40	43	46	49	90
91	0	2	4	7	9	11	14	16	18	21	23	25	28	31	33	36	39	41	44	47	50	91
92	0	2	5	7	9	11	14	16	19	21	24	26	29	31	34	37	39	42	45	48	51	92
93	0	2	5	7	9	12	14	17	19	22	24	27	29	32	35	37	40	43	46	49	52	93
94	0	2	5	7	10	12	14	17	19	22	25	27	30	33	35	38	41	44	47	50	53	94
95	0	2	5	7	10	12	15	17	20	22	25	28	30	33	36	39	42	45	48	51	54	95
96	0	2	5	7	10	12	15	18	20	23	26	28	31	34	37	40	43	46	49	52	55	96
97	0	3	5	8	10	13	15	18	21	23	26	29	32	35	38	41	44	47	50	53	56	97
98	0	3	5	8	10	13	16	18	21	24	27	29	32	35	38	41	44	48	51	54	58	98
99	0	3	5	8	11	13	16	19	21	24	27	30	33	36	39	42	45	49	52	55	59	99
100	0	3	5	8	11	13	16	19	22	25	28	31	34	37	40	43	46	50	53	56	60	100
Subt.	0"	30"	0"	30"	0"	30"	0"	30"	0"	30"	0"	30"	0"	30"	0"	30"	0"	30"	0"	30"	0"	Subt.
	0'		1'		2'		3'		4'		5'		6'		7'		8'		9'		10'	
Ther.	Mean refraction.																					Ther.

TABLE 23.

Correction of the Moon's Altitude for parallax and refraction corresponding to a mean value of the horizontal parallax, 57′ 30″.

Moon's alt.	Corr.	Moon's alt.	Corr.	Moon's alt.	Corr.	Moon's alt.	Corr.
°	′	°	′	°	′	°	′
10	51	31	48	51	35	71	18
11	52	32	47	52	35	72	17
12	52	33	47	53	34	73	17
13	52	34	46	54	33	74	16
14	52	35	46	55	32	75	15
15	52	36	45	56	32	76	14
16	52	37	45	57	31	77	13
17	52	38	44	58	30	78	12
18	52	39	44	59	29	79	11
19	52	40	43	60	28	80	10
20	51						
21	51	41	42	61	27	81	9
22	51	42	42	62	26	82	8
23	51	43	41	63	26	83	7
24	50	44	40	64	25	84	6
25	50	45	40	65	24	85	5
26	50	46	39	66	23	86	4
27	49	47	38	67	22	87	3
28	49	48	38	68	21	88	2
29	49	49	37	69	20	89	1
30	48	50	36	70	19	90	0

TABLE 24.

Correction of the Moon's Apparent Altitude for Parallax and Refraction.

[Barometer, 30 inches.—Fahrenheit's Thermometer, 50°.]

Moon's app. alt.	Horizontal parallax.								Seconds of parallax.	Correction for seconds of parallax.—Add.					Corr. for minutes of alt.
	54′	55′	56′	57′	58′	59′	60′	61′		0″	2″	4″	6″	8″	
° ′	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	″	″	″	″	″	″	
5 0	43 56	44 56	45 56	46 56	47 56	48 55	49 55	50 55	0	0	2	4	6	8	
10	44 11	45 11	46 11	47 11	48 11	49 10	50 10	51 10	10	10	12	14	16	18	
20	25	25	25	25	25	24	24	24	20	20	22	24	26	28	
30	39	39	38	38	38	38	37	37	30	30	32	34	36	38	
40	52	51	51	51	51	51	51	51	40	40	42	44	46	48	
50	45 4	46 3	47 3	48 3	49 3	50 3	51 3	52 3	50	50	52	54	56	58	
6 0	45 15	46 15	47 14	48 14	49 14	50 13	51 13	52 13	0	0	2	4	6	8	
10	26	26	25	25	25	25	25	25	10	10	12	14	16	18	
20	36	36	36	35	35	34	34	34	20	20	22	24	26	28	
30	46	46	45	45	45	44	44	44	30	30	32	34	36	38	
40	55	55	55	54	54	54	53	53	40	40	42	44	46	48	
50	46 4	47 3	48 3	49 3	50 3	51 2	52 1	53 1	50	50	52	54	56	58	
7 0	46 12	47 12	48 12	49 12	50 12	51 11	52 11	53 10	0	0	2	4	6	8	
10	21	20	20	20	19	18	18	18	10	10	12	14	16	18	
20	29	28	28	27	27	26	25	25	20	20	22	24	26	28	
30	36	36	35	35	34	34	34	33	30	30	32	34	36	38	
40	43	42	42	41	41	40	40	40	40	40	42	44	46	48	
50	50	49	48	48	48	47	46	46	50	50	52	54	56	58	Add.
8 0	46 56	47 56	48 55	49 54	50 54	51 54	52 53	53 53	0	0	2	4	6	8	1′ 1″
10	47 2	48 2	49 1	50 0	51 0	59	59	58	10	10	12	14	16	18	2 1
20	8	7	7	6	6	52 5	53 4	54 4	20	20	22	24	26	28	3 2
30	13	13	12	11	11	10	10	9	30	30	32	34	36	38	4 2
40	19	18	17	17	16	16	15	14	40	40	42	44	46	48	5 3
50	24	23	22	22	21	20	19	19	50	50	52	54	56	58	6 4
9 0	47 28	48 27	49 26	50 26	51 25	52 24	53 24	54 23	0	0	2	4	6	8	7 4
10	33	32	31	30	30	29	28	27	10	10	12	14	16	18	8 5
20	37	36	35	34	34	33	32	32	20	20	22	24	26	28	9 5
30	41	41	40	39	38	37	37	36	30	30	32	34	36	38	
40	45	44	43	43	42	41	40	39	40	40	42	44	46	48	
50	49	48	47	46	46	45	44	44	50	49	51	53	55	57	

TABLE 24.

Correction of the Moon's Apparent Altitude for Parallax and Refraction.

[Barometer 30 inches.—Fahrenheit's Thermometer 50°.]

Moon's app. alt.		Horizontal parallax.																Seconds of parallax.	Correction for seconds of parallax.—Add.					Corr. for minutes of alt.	
		54′		55′		56′		57′		58′		59′		60′		61′			0″	2″	4″	6″	8″		
°	′	′	″	′	″	′	″	′	″	′	″	′	″	′	″	′	″	″	″	″	″	″	″	Add.	
10	0	47	53	48	52	49	51	50	50	51	50	52	48	53	48	54	47	0	0	2	4	6	8	1′	0″
	10		56		55		54		53		52		51		50		50	10	10	12	14	16	18	2	1
	20		59		58		57		56		55		55		54		53	20	20	22	24	26	28	3	1
	30	48	2	49	1	50	0		59		58		57		56		55	30	29	31	33	35	37	4	1
	40		5		4		2	51	2	52	1	53	0		59		58	40	39	41	43	45	47	5	2
	50		7		6		5		4		4		2	54	1	55	0	50	49	51	53	55	57	6	2
11	0	48	10	49	9	50	8	51	7	52	7	53	5	54	4	55	3	0	0	2	4	6	8	7	2
	10		12		11		10		9		9		7		6		5	10	10	12	14	16	18	8	2
	20		15		14		12		12		11		9		8		7	20	20	22	24	26	28	9	3
	30		17		16		14		13		13		11		10		9	30	29	31	33	35	37		
	40		19		18		17		15		15		13		12		11	40	39	41	43	45	47		
	50		21		20		18		17		17		15		14		13	50	49	51	53	55	57		
12	0	48	22	49	21	50	19	51	18	52	17	53	17	54	15	55	14	0	0	2	4	6	8		
	10		24		23		21		20		19		18		16		15	10	10	12	14	16	18		
	20		26		25		23		22		21		20		18		17	20	20	22	24	25	27		
	30		27		26		24		23		22		20		19		18	30	29	31	33	35	37		
	40		28		27		25		24		23		21		20		19	40	39	41	43	45	47		
	50		29		28		26		25		24		22		21		20	50	49	51	53	55	57		
13	0	48	30	49	29	50	27	51	26	52	25	53	23	54	22	55	20	0	0	2	4	6	8	1	0
	10		31		30		28		27		26		24		22		21	10	10	12	14	16	18	2	0
	20		32		31		29		27		26		24		23		21	20	19	21	23	25	27	3	0
	30		33		32		30		28		27		25		23		22	30	29	31	33	35	37	4	0
	40		34		32		30		29		28		26		24		22	40	39	41	43	45	47	5	0
	50		35		33		31		30		28		26		25		23	50	49	51	53	55	57	6	0
14	0	48	35	49	33	50	31	51	30	52	28	53	26	54	25	55	23	0	0	2	4	6	8	7	0
	10		35		34		32		30		28		26		25		23	10	10	12	14	16	18	8	0
	20		36		34		32		30		29		27		25		24	20	19	21	23	25	27	9	0
	30		36		34		32		30		29		27		25		23	30	29	31	33	35	37		
	40		36		34		32		30		29		27		25		23	40	39	41	43	45	47		
	50		36		34		32		30		29		27		25		23	50	49	51	53	55	57		
15	0	48	36	49	35	50	33	51	31	52	29	53	27	54	25	55	23	0	0	2	4	6	8		
	10		36		35		32		30		28		26		24		22	10	10	12	14	16	18		
	20		36		35		32		30		28		26		24		22	20	19	21	23	25	27		
	30		36		34		31		29		28		25		23		21	30	29	31	33	35	37		
	40		36		34		31		29		27		25		23		21	40	39	41	43	45	47		
	50		35		33		30		28		26		24		21		19	50	49	51	53	55	57		
16	0	48	35	49	32	50	29	51	27	52	25	53	23	54	20	55	18	0	0	2	4	6	8		
	10		34		32		29		27		25		23		20		18	10	10	12	13	15	17		
	20		34		32		29		27		25		22		20		17	20	19	21	23	25	27		
	30		33		31		28		26		24		21		19		16	30	29	31	33	35	36		
	40		33		31		28		25		23		21		18		16	40	38	40	42	44	46		
	50		32		30		27		24		22		20		17		15	50	48	50	52	54	56	Sub.	
17	0	48	31	49	29	50	26	51	23	52	21	53	18	54	16	55	13	0	0	2	4	6	8	1′	0″
	10		30		28		25		22		20		17		14		12	10	10	12	13	15	17	2	0
	20		28		26		23		20		18		15		12		10	20	19	21	23	25	27	3	0
	30		27		25		22		19		17		14		11		9	30	29	31	33	34	36	4	0
	40		26		24		21		18		16		13		10		7	40	38	40	42	44	46	5	1
	50		26		23		20		17		15		12		9		6	50	48	50	52	53	55	6	1
18	0	48	24	49	21	50	18	51	15	52	13	53	10	54	7	55	4	0	0	2	4	6	8	7	1
	10		23		20		17		14		12		9		6		3	10	10	11	13	15	17	8	1
	20		22		19		16		13		11		8		5		2	20	19	21	23	25	27	9	1
	30		21		18		15		12		10		6		3		0	30	29	30	32	34	36		
	40		20		17		14		10		8		4		1	54	58	40	38	40	42	44	46		
	50		18		15		12		9		6		2	53	59		56	50	48	50	51	53	55		
19	0	48	16	49	13	50	10	51	7	52	4	53	0	53	57	54	55	0	0	2	4	6	8		
	10		15		12		8		5		2	52	59		55		53	10	10	11	13	15	17		
	20		13		10		6		3		0		57		53		51	20	19	21	23	25	27		
	30		12		8		5		2	51	58		55		51		49	30	29	30	32	34	36		
	40		10		6		3		0		56		53		49		47	40	38	40	42	44	46		
	50		9		5		2	50	58		55		51		48		45	50	48	50	51	53	55		

TABLE 24.

Correction of the Moon's Apparent Altitude for Parallax and Refraction.

[Barometer 30 inches.—Fahrenheit's Thermometer 50°.]

Moon's app. alt.	Horizontal parallax.								Seconds of parallax.	Correction for seconds of parallax.—Add.					Corr. for minutes of alt.
	54′	55′	56′	57′	58′	59′	60′	61′		0″	2″	4″	6″	8″	
° ′	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	″	″	″	″	″	″	Sub.
20 0	48 6	49 3	49 59	50 56	51 52	52 49	53 45	54 42	0	0	2	4	6	8	1′ 0″
10	5	2	58	55	51	47	43	40	10	9	11	13	15	17	2 0
20	3	0	56	52	49	45	41	37	20	19	21	23	24	26	3 1
30	1	48 58	53	50	46	42	38	35	30	28	30	32	34	36	4 1
40	59	56	52	48	44	40	36	33	40	38	39	41	43	45	5 1
50	57	54	50	46	42	38	34	30	50	47	49	51	53	54	6 1
21 0	47 55	48 51	49 47	50 43	51 39	52 35	53 31	54 28	0	0	2	4	6	7	7 1
10	53	49	45	41	37	33	29	26	10	9	11	13	15	17	8 1
20	51	47	43	39	35	31	27	23	20	19	21	22	24	26	9 2
30	48	44	40	36	32	28	24	20	30	28	30	32	34	35	
40	46	42	38	33	29	25	21	17	40	37	39	41	43	45	
50	43	39	35	31	27	22	18	14	50	47	49	50	52	54	
22 0	47 42	48 37	49 33	50 29	51 25	52 20	53 16	54 11	0	0	2	4	6	7	
10	40	35	30	26	22	17	13	8	10	9	11	13	15	17	
20	37	32	27	23	19	14	10	5	20	19	20	22	24	26	
30	34	30	25	20	16	11	7	3	30	28	30	31	33	35	
40	32	27	22	18	13	9	4	0	40	37	39	41	43	45	
50	29	25	20	15	11	6	1	53 57	50	46	48	50	52	54	
23 0	47 27	48 22	49 17	50 13	51 8	52 3	52 58	53 54	0	0	2	4	6	7	
10	25	20	15	10	5	0	55	51	10	9	11	13	15	17	
20	22	17	12	7	2	51 57	52	48	20	18	20	22	24	26	
30	19	14	9	4	0	54	49	45	30	28	29	31	33	35	
40	16	11	6	1	50 57	51	46	42	40	37	39	40	42	44	
50	13	8	3	49 58	54	48	43	38	50	46	48	50	51	53	
24 0	47 10	48 5	49 0	49 55	50 50	51 45	52 40	53 35	0	0	2	4	5	7	1 0
10	8	3	48 57	52	47	42	37	32	10	9	11	13	15	16	2 1
20	5	0	54	49	44	39	33	28	20	18	20	22	24	26	3 1
30	2	47 57	51	46	41	35	30	24	30	27	29	30	32	34	4 1
40	46 59	54	48	43	38	32	27	21	40	36	38	40	42	44	5 2
50	56	51	45	40	35	29	23	18	50	46	47	49	51	53	6 2
25 0	46 53	47 48	48 42	49 37	50 31	51 26	52 20	53 14	0	0	2	4	5	7	7 2
10	50	45	39	33	28	22	16	10	10	9	11	13	14	16	8 2
20	46	41	35	29	24	18	12	6	20	18	20	22	24	25	9 3
30	43	38	32	26	20	14	8	3	30	27	29	31	33	34	
40	40	34	28	23	17	11	5	52 59	40	36	38	40	42	43	
50	37	31	25	19	14	7	1	56	50	45	47	49	51	52	
26 0	46 34	47 28	48 22	49 16	50 10	51 4	51 58	52 52	0	0	2	4	5	7	
10	31	25	19	13	7	1	54	48	10	9	11	13	14	16	
20	27	21	15	9	3	50 57	50	44	20	18	20	22	23	25	
30	24	18	12	6	49 59	53	46	40	30	27	29	31	32	34	
40	20	14	8	2	55	49	42	36	40	36	38	39	41	43	
50	17	11	4	48 58	51	45	38	32	50	45	47	48	50	52	
27 0	46 14	47 7	48 1	48 54	49 48	50 41	51 35	52 28	0	0	2	4	5	7	1 0
10	11	4	47 58	51	44	37	31	24	10	9	11	12	14	16	2 1
20	7	1	54	47	40	33	27	20	20	18	20	21	23	25	3 1
30	3	46 57	50	43	36	29	23	16	30	27	28	30	32	34	4 1
40	45 59	53	46	39	32	25	19	12	40	36	37	39	41	43	5 2
50	56	49	42	35	28	21	15	8	50	44	46	48	50	52	6 2
28 0	45 53	46 46	47 38	48 31	49 24	50 17	51 11	52 4	0	0	2	4	5	7	7 3
10	49	42	34	27	20	13	6	51 59	10	9	11	12	14	16	8 3
20	45	38	30	23	16	9	2	55	20	18	19	21	23	25	9 3
30	41	34	26	19	12	5	50 57	50	30	26	28	30	32	33	
40	37	30	23	15	8	1	54	46	40	35	37	39	41	42	
50	34	26	19	11	4	49 57	49	42	50	44	46	48	49	51	
29 0	45 30	46 22	47 15	48 7	49 0	49 53	50 45	51 38	0	0	2	4	5	7	
10	26	18	11	3	48 56	49	40	34	10	9	10	12	14	16	
20	22	14	7	47 59	52	44	36	29	20	17	19	21	23	24	
30	18	10	2	55	47	39	31	24	30	26	28	30	31	33	
40	14	6	46 58	51	43	35	27	20	40	35	37	38	40	42	
50	11	3	55	47	39	31	23	15	50	44	45	47	49	51	

TABLE 24.

Correction of the Moon's Apparent Altitude for Parallax and Refraction.

[Barometer 30 inches.—Fahrenheit's Thermometer 50°.]

Moon's app. alt.	Horizontal parallax.								Seconds of parallax.	Correction for seconds of parallax.—Add.					Corr. for minutes of alt.
	54′	55′	56′	57′	58′	59′	60′	61′		0″	2″	4″	6″	8″	
° ′	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	″	″	″	″	″	″	Sub.
30 0	45 6	45 57	46 50	47 42	48 34	49 26	50 18	51 10	0	0	2	3	5	7	1′ 0″
10	2	54	46	38	30	22	13	6	10	9	10	12	14	16	2 1
20	44 58	50	42	34	26	18	9	1	20	17	19	21	23	24	3 1
30	54	46	37	29	21	13	4	50 56	30	26	28	29	31	33	4 2
40	50	42	33	25	17	8	0	52	40	35	36	38	40	42	5 2
50	45	38	29	21	12	4	49 55	47	50	43	45	47	49	50	6 3
31 0	44 41	45 33	46 24	47 16	48 7	48 59	49 50	50 42	0	0	2	3	5	7	7 3
10	37	29	20	12	2	54	45	37	10	9	10	12	14	15	8 4
20	33	24	15	7	47 58	49	40	32	20	17	19	21	22	24	9 4
30	28	20	11	2	54	45	36	27	30	26	27	29	31	32	
40	24	16	7	46 58	49	40	31	22	40	34	36	38	39	41	
50	20	11	2	53	44	35	26	17	50	43	44	46	48	50	
32 0	44 15	45 7	45 58	46 49	47 40	48 31	49 22	50 13	0	0	2	3	5	7	
10	11	3	53	44	35	26	17	8	10	8	10	12	14	15	
20	7	44 58	48	39	30	21	11	2	20	17	19	20	22	24	
30	3	53	44	34	25	16	6	49 57	30	25	27	29	30	32	
40	43 58	48	39	29	20	11	1	52	40	34	35	37	39	41	
50	54	44	34	24	15	6	48 56	47	50	42	44	46	47	49	
33 0	43 48	44 39	45 29	46 19	47 10	48 0	48 50	49 41	0	0	2	3	5	7	1 0
10	44	34	25	15	5	47 55	45	36	10	8	10	12	13	15	2 1
20	40	30	20	10	0	50	40	31	20	17	18	20	22	23	3 1
30	35	25	15	5	46 55	45	35	25	30	25	27	28	30	32	4 2
40	30	20	10	0	50	40	30	20	40	33	35	37	38	40	5 2
50	25	15	5	45 55	45	35	24	14	50	42	43	45	47	48	6 3
34 0	43 21	44 11	45 0	45 50	46 40	47 30	48 19	49 9	0	0	2	3	5	7	7 3
10	16	6	44 55	45	34	24	14	3	10	8	10	12	13	15	8 4
20	11	1	50	40	29	19	9	48 58	20	17	18	20	21	23	9 4
30	6	43 56	45	35	24	13	3	52	30	25	26	28	30	31	
40	1	51	40	30	19	8	47 58	47	40	33	35	36	38	40	
50	42 56	46	35	24	14	3	52	42	50	41	43	44	46	48	
35 0	42 52	43 41	44 30	45 19	46 9	46 58	47 47	48 36	0	0	2	3	5	7	
10	47	36	25	14	3	52	41	30	10	8	10	11	13	15	
20	42	31	20	9	45 58	47	36	25	20	16	18	20	21	23	
30	37	26	15	3	52	41	30	19	30	24	26	28	29	31	
40	32	21	10	44 58	47	36	25	14	40	33	34	36	38	39	
50	27	16	4	53	42	30	19	8	50	41	42	44	46	47	
36 0	42 22	43 11	43 59	44 48	45 37	46 25	47 14	48 2	0	0	2	3	5	6	
10	17	5	54	42	31	19	8	47 56	10	8	10	11	13	14	1 1
20	12	0	48	37	25	14	2	50	20	16	18	19	21	23	2 1
30	7	42 55	43	31	20	8	46 56	44	30	24	26	27	29	31	3 2
40	1	50	38	26	14	2	50	39	40	32	34	35	37	39	4 2
50	41 56	44	32	20	8	45 56	44	33	50	40	42	43	45	47	5 3
37 0	41 51	42 39	43 27	44 15	45 3	45 51	46 39	47 27	0	0	2	3	5	6	6 3
10	46	34	21	9	44 57	45	33	21	10	8	10	11	13	14	7 4
20	41	29	16	4	52	40	27	15	20	16	17	19	21	22	8 4
30	35	23	11	43 58	46	34	21	9	30	24	25	27	29	30	9 5
40	30	18	5	53	40	28	15	3	40	32	33	35	37	38	
50	25	12	42 59	47	34	22	9	46 57	50	40	41	43	45	46	
38 0	41 19	42 7	42 54	43 41	44 29	45 16	46 3	46 51	0	0	2	3	5	6	
10	14	2	49	36	23	10	45 57	45	10	8	9	11	13	14	
20	8	41 56	43	30	17	4	51	38	20	16	17	19	20	22	
30	3	51	38	24	12	44 58	45	32	30	23	25	27	28	30	
40	40 58	45	32	18	6	52	39	26	40	31	33	35	36	38	
50	52	39	26	13	0	46	33	20	50	39	41	42	44	46	
39 0	40 47	41 33	42 20	43 7	43 54	44 40	45 27	46 13	0	0	2	3	5	6	
10	42	28	15	1	48	34	21	7	10	8	9	11	12	14	1 1
20	36	23	9	42 55	42	28	15	1	20	15	17	19	20	22	2 1
30	30	17	3	49	36	22	8	45 54	30	23	25	26	28	29	3 2
40	25	11	41 57	43	30	16	2	48	40	31	32	34	36	37	4 2
50	19	5	51	37	23	9	44 55	42	50	39	40	42	43	45	5 3

TABLE 24.

Correction of the Moon's Apparent Altitude for Parallax and Refraction.

[Barometer 30 inches.—Fahrenheit's Thermometer 50°.]

Moon's app. alt.	Horizontal parallax. 54′	55′	56′	57′	58′	59′	60′	61′	Seconds of parallax.	Correction for seconds of parallax.—Add. 0″	2″	4″	6″	8″	Corr. for minutes of alt.
° ′	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	″	″	″	″	″	″	Sub.
40 0	40 14	41 0	41 46	42 32	43 18	44 4	44 50	45 36	0	0	2	3	5	6	6′ 3″
10	8	40 54	39	25	11	43 57	43	29	10	8	9	11	12	14	7 4
20	2	48	33	19	5	50	36	22	20	15	17	18	20	21	8 5
30	39 56	42	28	13	42 59	44	30	16	30	23	24	26	27	29	9 5
40	50	36	22	7	53	38	24	9	40	30	32	34	35	37	
50	45	30	16	1	47	32	18	3	50	38	40	41	43	44	
41 0	39 39	40 24	41 10	41 55	42 41	43 26	44 11	44 56	0	0	2	3	5	6	
10	33	18	4	49	34	19	4	49	10	8	9	11	12	14	
20	27	12	40 58	43	28	13	43 58	43	20	15	17	18	20	21	
30	21	6	51	36	22	7	51	37	30	23	24	26	27	29	
40	16	0	45	30	16	0	45	30	40	30	32	33	35	36	
50	10	39 54	39	24	9	42 53	38	23	50	38	39	41	42	44	
42 0	39 4	39 48	40 33	41 17	42 2	42 47	43 31	44 16	0	0	1	3	4	6	
10	38 58	42	27	11	41 56	41	25	10	10	7	9	10	12	13	1 1
20	52	36	21	5	50	34	18	3	20	15	16	18	19	21	2 1
30	46	30	14	40 58	43	27	11	43 56	30	22	24	25	27	28	3 2
40	40	24	8	52	36	21	5	49	40	30	31	33	34	36	4 2
50	34	18	2	46	30	14	42 58	42	50	37	38	40	41	43	5 3
43 0	38 28	39 12	39 56	40 40	41 24	42 8	42 52	43 36	0	0	1	3	4	6	6 4
10	22	6	50	34	18	1	45	29	10	7	9	10	12	13	7 4
20	16	38 59	43	27	11	41 54	38	22	20	15	16	18	19	20	8 5
30	10	53	37	20	5	48	31	15	30	22	23	25	26	28	9 5
40	4	47	30	14	40 58	41	24	8	40	29	31	32	34	35	
50	37 57	41	24	7	51	34	17	1	50	37	38	39	41	42	
44 0	37 51	38 35	39 18	40 1	40 44	41 27	42 10	42 54	0	0	1	3	4	6	
10	45	28	11	39 54	37	20	3	46	10	7	9	10	11	13	
20	38	21	4	47	30	13	41 56	39	20	14	16	17	19	20	
30	32	15	38 58	41	24	7	49	32	30	21	23	24	26	27	
40	26	9	51	34	17	0	42	25	40	29	30	31	33	34	
50	20	2	44	27	10	40 53	35	18	50	36	37	39	40	41	
45 0	37 14	37 56	38 38	39 21	40 3	40 46	41 28	42 11	0	0	1	3	4	6	1 1
10	7	49	31	14	39 56	39	21	3	10	7	8	10	11	13	2 1
20	0	43	25	7	49	32	14	41 56	20	14	15	17	18	20	3 2
30	36 54	37	18	1	43	25	7	49	30	21	23	24	25	27	4 3
40	48	30	11	38 54	36	18	0	42	40	28	30	31	32	34	5 3
50	41	23	4	47	29	11	40 52	34	50	35	37	38	39	41	6 4
46 0	36 35	37 17	37 58	38 40	39 22	40 4	40 45	41 27	0	0	1	3	4	6	7 5
10	29	10	51	33	15	39 57	38	20	10	7	8	10	11	12	8 5
20	22	3	44	26	8	49	31	12	20	14	15	17	18	19	9 6
30	16	36 57	38	20	1	42	24	5	30	21	22	23	25	26	
40	9	50	32	13	38 54	35	17	40 58	40	28	29	30	32	33	
50	2	43	25	6	47	28	9	50	50	35	36	37	39	40	
47 0	35 56	36 37	37 18	37 59	38 40	39 21	40 2	40 43	0	0	1	3	4	5	
10	49	30	11	52	34	14	39 55	36	10	7	8	10	11	12	
20	42	23	4	45	26	6	47	28	20	14	15	16	18	19	
30	36	17	36 57	38	19	38 59	40	21	30	20	22	23	24	26	
40	30	10	50	31	12	52	32	13	40	27	29	30	31	33	
50	23	3	43	24	5	45	25	5	50	34	35	37	38	39	
48 0	35 16	35 56	36 36	37 17	37 57	38 37	39 17	39 58	0	0	1	3	4	5	1 1
10	10	50	30	10	50	30	10	50	10	7	8	9	11	12	2 1
20	3	43	23	2	43	22	2	42	20	13	15	16	17	19	3 2
30	34 56	36	16	36 55	35	15	38 55	34	30	20	21	23	24	25	4 3
40	49	29	9	48	28	8	48	27	40	27	28	29	31	32	5 3
50	42	22	1	41	21	0	40	19	50	33	35	36	37	39	6 4
49 0	34 35	35 15	35 54	36 34	37 13	37 53	38 32	39 11	0	0	1	3	4	5	7 5
10	29	8	47	27	6	46	25	4	10	7	8	9	10	12	8 5
20	22	1	40	20	36 59	38	17	38 56	20	13	14	16	17	18	9 6
30	15	34 54	33	12	51	30	9	48	30	20	21	22	23	25	
40	8	47	26	5	44	23	2	41	40	26	27	29	30	31	
50	1	40	19	35 58	36	15	37 54	33	50	33	34	35	36	38	

TABLE 24.

Correction of the Moon's Apparent Altitude for Parallax and Refraction.

[Barometer 30 inches.—Fahrenheit's Thermometer 50°.]

oon's pp. alt.	Horizontal parallax.								Seconds of parallax.	Correction for seconds of parallax.—Add.					Corr. for minutes of alt.
	54′	55′	56′	57′	58′	59′	60′	61′		0″	2″	4″	6″	8″	
° ′	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	″	″	″	″	″	″	
0 0	33 54	34 33	35 11	35 50	36 29	37 8	37 46	38 25	0	0	1	3	4	5	
10	47	26	4	43	21	0	38	17	10	6	8	9	10	12	
20	40	19	34 57	36	14	36 53	31	9	20	13	14	15	17	18	
30	33	11	49	28	6	45	23	1	30	19	20	22	23	24	
40	26	4	42	20	35 58	37	15	37 53	40	26	27	28	29	31	
50	19	33 57	35	13	51	29	7	45	50	32	33	35	36	37	Sub.
1 0	33 12	33 50	34 28	35 6	35 44	36 22	36 59	37 37	0	0	1	3	4	5	1′ 1″
10	5	43	21	34 58	36	14	51	29	10	6	8	9	10	11	2 1
20	32 58	36	13	50	28	6	43	21	20	13	14	15	16	18	3 2
30	51	29	6	43	21	35 58	36	13	30	19	20	21	23	24	4 3
40	44	22	33 59	36	14	50	28	5	40	25	26	28	29	30	5 4
50	37	14	51	28	6	42	20	36 57	50	31	33	34	35	36	6 4
2 0	32 30	33 7	33 44	34 21	34 58	35 35	36 12	36 49	0	0	1	2	4	5	7 5
10	23	0	36	13	50	27	4	41	10	6	7	9	10	11	8 6
20	15	32 52	29	6	43	19	35 56	33	20	12	13	15	16	17	9 6
30	8	45	21	33 58	35	11	48	24	30	18	20	21	22	23	
40	1	38	14	50	27	3	40	16	40	24	26	27	28	29	
50	31 54	31	7	43	19	34 55	32	8	50	31	32	33	34	35	
3 0	31 47	32 23	32 59	33 35	34 11	34 47	35 24	36 0	0	0	1	2	4	5	
10	39	15	51	27	3	39	15	35 51	10	6	7	8	10	11	
20	32	8	44	20	33 56	31	7	43	20	12	13	14	16	17	
30	25	0	36	12	48	23	34 59	35	30	18	19	20	22	23	
40	17	31 53	28	4	40	15	51	27	40	24	25	26	28	29	
50	10	46	21	32 57	32	7	43	19	50	30	31	32	34	35	
4 0	31 3	31 38	32 13	32 49	33 24	33 59	34 35	35 10	0	0	1	2	4	5	
10	30 55	30	5	41	16	51	26	1	10	6	7	8	9	11	
20	48	22	31 57	33	8	43	18	34 53	20	12	13	14	15	16	
30	40	15	49	25	0	35	10	45	30	18	19	20	21	22	
40	33	8	42	17	32 52	27	1	37	40	23	25	26	27	28	
50	28	0	35	9	44	19	33 53	28	50	29	30	32	33	34	
5 0	30 18	30 52	31 27	32 1	32 36	33 10	33 45	34 19	0	0	1	2	3	5	
10	10	45	19	31 53	28	2	36	11	10	6	7	8	9	10	
20	3	38	12	46	20	32 54	28	3	20	11	13	14	15	16	
30	29 55	30	4	38	12	46	20	33 54	30	17	18	19	20	22	
40	48	22	30 56	30	4	37	11	45	40	23	24	25	26	27	
50	40	14	48	22	31 55	29	3	37	50	28	30	31	32	33	
6 0	29 33	30 7	30 40	31 14	31 47	32 21	32 55	33 28	0	0	1	2	3	4	
10	25	29 59	32	6	39	13	46	20	10	6	7	8	9	10	
20	18	51	24	30 58	31	4	37	11	20	11	12	13	14	16	
30	10	43	16	50	23	31 56	29	2	30	17	18	19	20	21	1 1
40	3	36	9	42	15	48	21	32 54	40	22	23	24	25	27	2 2
50	28 55	28	1	34	7	40	12	45	50	28	29	30	31	32	3 2
7 0	28 47	29 20	29 53	30 25	30 58	31 31	32 3	32 36	0	0	1	2	3	4	4 3
10	39	12	45	17	50	22	31 55	27	10	5	6	7	9	10	5 4
20	32	5	37	9	42	14	47	19	20	11	12	13	14	15	6 5
30	24	28 57	29	1	33	6	38	10	30	16	17	18	19	21	7 5
40	17	49	21	29 53	25	30 57	29	1	40	22	23	24	25	26	8 6
50	9	41	13	45	17	49	21	31 52	50	27	28	29	30	31	9 7
8 0	28 1	28 33	29 5	29 37	30 9	30 41	31 12	31 44	0	0	1	2	3	4	
10	27 53	25	28 57	28	0	32	4	35	10	5	6	7	8	9	
20	45	17	49	20	29 52	23	30 55	26	20	10	12	13	14	15	
30	38	9	41	12	44	15	46	17	30	16	17	18	19	20	
40	30	1	33	4	35	6	38	9	40	21	22	23	24	25	
50	22	27 53	24	28 55	27	29 58	29	0	50	26	27	28	29	30	
9 0	27 14	27 45	28 16	28 47	29 18	29 49	30 20	30 51	0	0	1	2	3	4	
10	6	37	7	38	9	40	11	42	10	5	6	7	8	9	
20	26 58	29	27 59	30	1	31	2	33	20	10	11	12	13	14	
30	51	21	51	22	28 53	23	29 54	24	30	15	16	17	18	19	
40	43	13	43	14	44	14	45	15	40	20	21	22	23	24	
50	35	5	35	5	36	6	36	6	50	25	26	27	29	30	

TABLE 24.

Correction of the Moon's Apparent Altitude for Parallax and Refraction.

[Barometer 30 inches.—Fahrenheit's Thermometer 50°.]

Moon's app. alt.	Horizontal parallax.								Seconds of parallax.	Correction for seconds of parallax.—Add.					Corr. for minutes of alt.
	54'	55'	56'	57'	58'	59'	60'	61'		0"	2"	4"	6"	8"	
° '	' "	' "	' "	' "	' "	' "	' "	' "	"	"	"	"	"	"	
60 0	26 26	26 57	27 27	27 57	28 27	28 57	29 27	29 57	0	0	1	2	3	4	
10	19	49	19	49	19	49	18	48	10	5	6	7	8	9	
20	11	41	11	40	10	40	9	39	20	10	11	12	13	14	
30	3	32	2	31	1	31	0	30	30	15	16	17	18	19	
40	25 55	24	26 53	23	27 53	22	28 51	21	40	20	21	22	23	24	
50	47	16	45	14	44	13	42	12	50	25	26	27	28	29	
61 0	25 39	26 8	26 37	27 6	27 36	28 5	28 34	29 3	0	0	1	2	3	4	
10	31	0	29	26 58	27	27 56	25	28 54	10	5	6	7	8	9	
20	23	25 52	20	49	18	47	16	45	20	10	11	12	12	13	
30	15	43	12	40	10	38	7	35	30	14	15	16	17	18	
40	7	35	4	32	1	29	27 58	26	40	19	20	21	22	23	
50	24 59	27	25 55	24	26 52	20	49	17	50	24	25	26	27	28	
62 0	24 50	25 19	25 47	26 15	26 43	27 11	27 40	28 8	0	0	1	2	3	4	
10	42	10	38	6	34	2	30	27 58	10	5	6	6	7	8	
20	34	2	29	25 57	25	26 53	21	49	20	9	10	11	12	12	
30	26	24 54	21	49	17	45	12	40	30	14	15	16	17	18	
40	18	46	13	41	8	36	3	31	40	19	19	20	21	22	
50	10	37	4	32	25 59	27	26 54	21	50	23	24	25	26	27	
63 0	24 2	24 29	24 56	25 23	25 51	26 18	26 45	27 12	0	0	1	2	3	4	
10	23 54	21	48	15	42	9	36	3	10	4	5	6	7	8	
20	46	13	39	6	33	0	27	26 54	20	9	10	11	12	13	
30	37	4	31	24 58	24	25 51	18	45	30	13	14	15	16	17	
40	29	23 55	22	49	15	42	8	35	40	18	19	20	21	22	
50	20	47	13	40	6	33	25 59	26	50	22	23	24	25	26	
64 0	23 12	23 39	24 5	24 32	24 58	25 24	25 50	26 17	0	0	1	2	3	3	
10	4	31	23 57	23	49	15	41	8	10	4	5	6	7	8	
20	22 56	22	48	14	40	6	32	25 58	20	9	10	10	11	12	
30	47	13	39	5	31	24 57	22	48	30	13	14	15	16	16	
40	39	5	30	23 56	22	48	13	39	40	17	18	19	20	21	
50	31	22 57	22	48	13	39	4	30	50	22	23	23	24	25	
65 0	22 23	22 48	23 13	23 39	24 4	24 30	24 55	25 21	0	0	1	2	2	3	Sub.
10	14	40	5	30	23 55	20	46	11	10	4	5	6	7	7	1' 1"
20	6	31	22 56	21	46	11	36	1	20	8	9	10	11	12	2 2
30	21 58	23	48	13	37	2	27	24 52	30	13	13	14	15	16	3 3
40	49	14	39	4	28	23 53	18	43	40	17	18	18	19	20	4 4
50	41	6	30	22 55	19	44	8	33	50	21	22	23	23	24	5 5
66 0	21 32	21 57	22 21	22 46	23 10	23 35	23 59	24 23	0	0	1	2	2	3	6 5
10	24	48	12	37	1	25	49	14	10	4	5	6	7	7	7 6
20	15	39	3	28	22 52	15	40	4	20	8	9	10	11	11	8 7
30	7	31	21 55	19	43	6	31	23 55	30	12	13	14	15	16	9 8
40	20 59	22	46	10	34	22 57	21	45	40	16	17	18	19	20	
50	50	14	37	1	25	48	12	36	50	20	21	22	23	24	
67 0	20 41	21 5	21 28	21 52	22 15	22 39	23 2	23 26	0	0	1	2	2	3	
10	33	20 56	19	43	6	29	22 52	16	10	4	5	5	6	7	
20	25	48	11	34	21 57	20	43	7	20	8	8	9	10	11	
30	16	39	2	25	48	11	34	22 57	30	12	12	13	14	15	
40	8	30	20 53	16	39	2	24	47	40	15	16	17	18	18	
50	19 59	21	44	7	30	21 52	15	37	50	19	20	21	22	22	
68 0	19 50	20 13	20 35	20 58	21 21	21 43	22 5	22 28	0	0	1	1	2	3	
10	42	4	27	49	12	34	21 56	19	10	4	4	5	6	7	
20	33	19 56	18	40	2	24	47	9	20	7	8	9	9	10	
30	25	47	9	31	20 53	15	37	21 59	30	11	12	13	13	14	
40	16	38	0	22	44	5	27	49	40	15	16	16	17	18	
50	7	29	19 51	13	34	20 56	17	39	50	18	19	20	21	21	
69 0	18 59	19 21	19 42	20 4	20 25	20 47	21 8	21 30	0	0	1	1	2	3	
10	50	12	33	19 55	16	37	20 59	20	10	4	4	5	6	6	
20	42	3	24	45	7	28	49	10	20	7	8	8	9	10	
30	33	18 54	15	36	19 57	18	39	0	30	11	11	12	13	13	
40	24	45	6	27	48	9	29	20 50	40	14	15	15	16	17	
50	16	37	18 57	18	39	0	20	41	50	18	18	19	20	20	

TABLE 24.

Correction of the Moon's Apparent Altitude for Parallax and Refraction.

[Barometer 30 inches.—Fahrenheit's Thermometer 50°.]

Moon's app. alt.	Horizontal parallax.								Seconds of parallax.	Correction for seconds of parallax.—Add.					Corr. for minutes of alt.
	54′	55′	56′	57′	58′	59′	60′	61′		0″	2″	4″	6″	8″	
° ′	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	″	″	″	″	″	″	
70 0	18 7	18 28	18 48	19 9	19 30	19 50	20 11	20 31	0	0	1	1	2	3	
10	17 58	19	39	0	20	41	1	21	10	3	4	5	5	6	
20	50	10	30	18 50	11	31	19 51	11	20	7	7	8	9	9	
30	41	1	21	41	1	21	41	1	30	10	11	11	12	13	
40	32	17 53	12	32	18 52	12	32	19 52	40	13	14	15	15	16	
50	24	44	3	23	43	3	22	42	50	17	17	18	19	19	
71 0	17 15	17 35	17 54	18 14	18 34	18 53	19 12	19 32	0	0	1	1	2	3	
10	6	26	45	5	24	43	3	22	10	3	4	4	5	6	
20	16 57	17	36	17 55	14	33	18 53	12	20	6	7	8	8	9	
30	48	8	27	46	5	24	43	2	30	10	10	11	12	12	
40	40	16 59	18	37	17 56	15	34	18 52	40	13	13	14	15	15	
50	31	50	9	28	47	5	24	42	50	16	17	17	18	19	
72 0	16 22	16 41	17 0	17 18	17 37	17 55	18 14	18 32	0	0	1	1	2	2	
10	13	32	16 50	9	27	46	4	22	10	3	4	4	5	5	
20	5	23	41	16 59	18	36	17 54	12	20	6	7	7	8	8	
30	15 57	14	32	50	9	27	45	3	30	9	10	10	11	11	
40	48	5	23	41	16 59	17	35	17 53	40	12	13	13	14	14	
50	39	15 56	14	32	50	7	25	43	50	15	16	16	17	18	
73 0	15 30	15 47	16 5	16 22	16 40	16 58	17 15	17 33	0	0	1	1	2	2	
10	21	38	15 56	13	30	48	5	23	10	3	3	4	5	5	
20	12	29	47	4	21	39	16 56	13	20	6	6	7	7	8	
30	3	20	37	15 55	12	29	46	3	30	9	9	10	10	11	
40	14 54	11	28	45	2	19	36	16 53	40	11	12	13	13	14	
50	45	2	19	35	15 52	9	26	42	50	14	15	15	16	17	
74 0	14 36	14 53	15 9	15 26	15 42	15 59	16 16	16 32	0	0	1	1	2	2	Sub.
10	28	44	0	17	33	49	6	22	10	3	3	4	4	5	1′ 1″
20	19	35	14 51	8	24	40	15 56	12	20	5	6	6	7	8	2 2
30	10	26	42	14 58	14	30	46	2	30	8	9	9	10	11	3 3
40	1	17	33	49	5	20	36	15 52	40	11	11	12	12	13	4 4
50	13 52	8	23	39	14 55	10	26	42	50	13	14	14	15	16	5 5
75 0	13 43	13 59	14 14	14 29	14 45	15 1	15 16	15 32	0	0	1	1	2	2	6 6
10	34	50	5	20	36	14 52	7	22	10	3	3	4	4	5	7 7
20	25	41	13 56	11	27	42	14 57	12	20	5	6	6	7	7	8 8
30	16	32	46	1	17	32	47	2	30	8	8	9	9	10	9 9
40	7	22	37	13 52	7	22	37	14 51	40	10	11	11	12	12	
50	12 58	13	28	42	13 57	12	27	41	50	13	13	14	14	15	
76 0	12 49	13 4	13 18	13 33	13 47	14 2	14 17	14 31	0	0	0	1	1	2	
10	41	12 55	9	24	38	13 53	7	21	10	2	3	3	4	4	
20	32	46	0	14	28	43	13 57	11	20	5	5	6	6	7	
30	23	37	12 51	5	19	33	47	1	30	7	8	8	8	9	
40	14	27	41	12 55	9	23	36	13 50	40	9	10	10	11	11	
50	5	18	32	45	12 59	13	26	40	50	12	12	13	13	14	
77 0	11 56	12 9	12 22	12 36	12 49	13 3	13 16	13 30	0	0	0	1	1	2	
10	47	0	13	27	40	12 53	7	20	10	2	3	3	4	4	
20	38	11 51	4	17	30	43	12 57	10	20	4	5	5	6	6	
30	29	42	11 55	8	21	33	47	0	30	7	7	7	8	8	
40	19	32	45	11 58	11	23	36	12 49	40	9	9	9	10	10	
50	10	23	35	48	1	13	26	39	50	11	11	12	12	13	
78 0	11 1	11 14	11 26	11 39	11 52	12 4	12 16	12 29	0	0	0	1	1	2	
10	10 52	5	17	30	42	11 54	6	19	10	2	2	3	3	4	
20	43	10 55	8	20	32	44	11 56	8	20	4	4	5	5	6	
30	34	46	10 58	10	22	34	46	11 58	30	6	6	7	7	8	
40	25	37	48	0	12	24	36	48	40	8	8	9	9	10	
50	16	28	39	10 51	3	15	26	38	50	10	10	11	11	12	
79 0	10 7	10 19	10 30	10 42	10 53	11 5	11 16	11 28	0	0	0	1	1	1	
10	9 58	9	21	32	43	10 55	6	17	10	2	2	3	3	3	
20	49	0	11	22	33	44	10 56	7	20	4	4	4	5	5	
30	40	9 50	1	12	23	34	45	10 56	30	6	6	6	7	7	
40	31	41	9 52	3	13	24	35	46	40	7	8	8	8	9	
50	22	32	43	9 54	4	15	25	36	50	9	10	10	10	11	

TABLE 24.

Correction of the Moon's Apparent Altitude for Parallax and Refraction.

[Barometer 30 inches.—Fahrenheit's Thermometer 50°.]

Moon's app. alt.	Horizontal parallax.								Seconds of parallax.	Correction for seconds of parallax.—Add.					Corr. for minutes of alt.
	54′	55′	56′	57′	58′	59′	60′	61′		0″	2″	4″	6″	8″	
° ′	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	″	″	″	″	″	″	
80 0	9 13	9 23	9 34	9 44	9 55	10 5	10 15	10 26	0	0	0	1	1	1	
10	3	14	24	34	45	9 55	5	15	10	2	2	2	3	3	
20	8 54	4	14	24	35	45	9 55	5	20	3	4	4	4	5	
30	45	8 55	5	15	25	35	45	9 54	30	5	5	6	6	6	
40	36	46	8 55	5	15	25	35	44	40	7	7	7	8	8	
50	27	37	46	8 56	6	15	25	34	50	8	9	9	9	10	
81 0	8 18	8 27	8 37	8 46	8 56	9 5	9 14	9 24	0	0	0	1	1	1	
10	9	18	27	36	46	8 55	4	13	10	1	2	2	2	3	
20	7 59	8	17	26	36	45	8 54	3	20	3	3	4	4	4	
30	50	7 59	8	17	26	35	44	8 52	30	4	5	5	5	6	
40	41	50	7 59	8	17	25	34	42	40	6	6	6	7	7	
50	32	41	49	7 58	7	15	24	32	50	7	8	8	8	9	
82 0	7 23	7 31	7 40	7 48	7 57	8 5	8 13	8 22	0	0	0	1	1	1	
10	14	22	30	38	47	7 55	3	11	10	1	2	2	2	2	
20	4	12	20	28	37	45	7 52	0	20	3	3	3	3	4	
30	6 55	3	11	19	27	35	42	7 50	30	4	4	5	5	5	
40	46	6 54	2	10	17	25	32	40	40	5	6	6	6	6	
50	37	45	6 52	0	7	15	22	30	50	7	7	7	7	8	
83 0	6 28	6 35	6 43	6 50	6 57	7 5	7 12	7 20	0	0	0	0	1	1	Sub.
10	19	26	33	40	47	6 54	2	9	10	1	1	2	2	2	1′ 1″
20	9	16	23	30	37	44	6 51	6 58	20	2	3	3	3	3	2 2
30	0	7	13	20	27	34	41	48	30	3	4	4	4	4	3 3
40	5 51	5 58	4	11	18	24	31	38	40	5	5	5	5	6	4 4
50	42	49	5 55	1	8	14	21	27	50	6	6	6	6	7	5 5
84 0	5 33	5 39	5 45	5 52	5 58	6 4	6 10	6 17	0	0	0	0	1	1	6 6
10	23	30	36	42	48	5 54	0	6	10	1	1	1	2	2	7 7
20	14	20	26	32	38	44	5 50	5 55	20	2	2	2	3	3	8 8
30	5	10	16	22	28	34	39	45	30	3	3	3	3	4	9 9
40	4 56	1	7	13	18	24	29	35	40	4	4	4	4	5	
50	47	4 52	4 58	3	8	14	19	25	50	5	5	5	5	6	
85 0	4 37	4 43	4 48	4 53	4 58	5 4	5 9	5 14	0	0	0	0	0	1	
10	28	33	38	43	48	4 53	4 58	3	10	1	1	1	1	1	
20	18	24	28	33	38	43	48	4 53	20	2	2	2	2	2	
30	9	14	19	23	28	33	38	43	30	2	3	3	3	3	
40	0	5	10	14	19	23	28	33	40	3	3	4	4	4	
50	3 51	3 56	0	5	9	13	18	22	50	4	4	4	5	5	
86 0	3 42	3 46	3 50	3 55	3 59	4 3	4 7	4 11	0	0	0	0	0	1	
10	33	37	41	45	49	3 53	3 57	1	10	1	1	1	1	1	
20	23	27	31	35	39	43	46	3 50	20	1	1	2	2	2	
30	14	18	21	25	29	33	36	40	30	2	2	2	2	2	
40	5	9	12	16	19	23	26	30	40	3	3	3	3	3	
50	2 56	2 59	3	6	9	13	16	19	50	3	3	3	4	4	
87 0	2 47	2 50	2 53	2 56	2 59	3 2	3 5	3 9	0	0	0	0	0	0	
10	37	40	43	46	49	2 52	2 55	2 58	10	0	1	1	1	1	
20	28	31	33	36	39	42	45	47	20	1	1	1	1	1	
30	19	21	24	26	29	32	34	37	30	1	1	2	2	2	
40	10	12	15	17	19	22	24	27	40	2	2	2	2	2	
50	1	3	5	7	9	12	14	16	50	2	2	2	3	3	
88 0	1 51	1 53	1 55	1 57	1 59	2 2	2 4	2 6	0	0	0	0	0	0	
10	42	43	45	47	49	1 51	1 53	1 55	10	0	0	0	0	0	
20	32	34	36	38	39	41	43	44	20	1	1	1	1	1	
30	23	25	26	28	29	31	32	34	30	1	1	1	1	1	
40	14	15	16	19	20	21	22	24	40	1	1	1	1	1	
50	5	6	7	9	10	11	12	13	50	1	1	1	2	2	
89 0	0 56	0 57	0 58	0 59	1 0	1 1	1 2	1 3	0	0	0	0	0	0	
10	46	47	48	49	0 50	0 51	0 51	0 52	10	0	0	0	0	0	
20	37	37	38	39	40	40	41	42	20	0	0	0	0	0	
30	28	28	28	29	30	30	31	31	30	0	0	0	0	0	
40	19	19	19	19	20	20	21	21	40	0	0	0	0	0	
50	9	10	10	10	10	10	10	10	50	1	1	1	1	1	

TABLE 25.

Table showing the variation of the altitude of an object arising from a change of 100 seconds in the declination. Unmarked quantities in the Table are positive. If the change move the body toward the elevated pole, apply the correction to the altitude with the signs in the Table; otherwise, change the signs.

Declination.	Altitude.	Latitude of same name as declination.								Latitude of different name from declination.							Altitude.	Declination.
		70°	60°	50°	40°	30°	20°	10°	0°	10°	20°	30°	40°	50°	60°	70°		
°	°	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	°	°
0	0	94	87	76	64	50	34	17	0	17	34	50	64	76	87	94	0	0
	10	95	88	78	65	51	35	18	0	18	35	51	65	78	88	95	10	
	20	100	92	82	68	53	36	18	0	18	36	53	68	82	92	100	20	
	30		100	88	74	57	39	20	0	20	39	57	74	88	100		30	
	40			100	84	65	45	22	0	22	45	65	84	100			40	
	50				100	78	53	27	0	27	53	78	100				50	
	60					100	68	35	0	35	68	100					60	
	70						100	51	0	51	100						70	
2	0	94	87	77	64	50	34	17	0	17	34	50	64	77	87	94	0	2
	10	95	87	77	65	50	34	17	−1	18	35	51	66	78	88	96	10	
	20	99	91	81	67	52	35	17	−1	19	37	54	69	83	93	101	20	
	30	107	98	87	73	56	38	18	−2	22	41	59	76	90	102		30	
	40		111	98	82	63	42	20	−2	25	47	68	86	102			40	
	50			116	97	74	50	24	−3	30	57	81	103				50	
	60				124	95	64	30	−5	40	73	103					60	
	70					139	92	43	−8	59	108						70	
4	0	94	87	77	64	50	34	17	0	17	34	50	64	77	87	94	0	4
	10	94	87	77	64	50	34	16	−1	19	36	52	67	79	89	97	10	
	20	98	90	79	66	51	34	16	−3	21	39	56	71	84	95	103	20	
	30	105	96	85	70	54	36	16	−4	24	44	62	78	93	104		30	
	40		107	94	78	59	39	17	−6	29	51	71	90	106			40	
	50			111	92	70	45	19	−8	35	62	86	109				50	
	60				117	88	56	23	−12	47	81	112					60	
	70					127	81	32	−19	70	119						70	
6	0	94	87	77	65	50	34	17	0	17	34	50	65	77	87	94	0	6
	10	94	87	76	64	49	33	16	−2	20	37	53	67	80	90	98	10	
	20	97	89	78	65	50	33	15	−4	22	40	57	73	86	96	104	20	
	30	103	94	83	69	52	34	14	−6	26	46	64	81	95	107		30	
	40		105	92	76	57	36	14	−9	32	54	74	93	109			40	
	50			107	88	66	41	15	−13	40	66	91	113				50	
	60				111	82	51	17	−18	53	87	119					60	
	70					118	72	22	−29	80	129						70	
8	0	95	87	77	65	50	35	18	0	18	35	50	65	77	87	95	0	8
	10	94	86	76	63	49	33	15	−3	20	38	54	68	81	91	99	10	
	20	96	88	77	64	49	32	14	−5	24	40	59	74	87	98	106	20	
	30	101	93	81	67	50	32	12	−8	28	48	66	83	97	109		30	
	40		102	89	73	54	33	11	−12	35	57	78	97	113			40	
	50			104	84	62	37	11	−17	44	70	95	118				50	
	60				105	77	45	11	−24	59	93	125					60	
	70					109	62	13	−39	90	140						70	
10	0	95	88	78	65	51	35	18	0	18	35	51	65	78	88	95	0	10
	10	94	86	75	63	48	32	15	−3	21	38	55	69	82	92	100	10	
	20	95	87	76	63	48	31	12	−6	25	43	60	76	89	100		20	
	30	100	91	80	65	49	30	10	−10	30	50	69	86	100			30	
	40		100	87	70	51	31	8	−15	38	60	81	100				40	
	50			100	81	58	33	6	−21	48	75	100					50	
	60				100	71	39	5	−31	66	100						60	
	70					100	53	3	−48	100							70	
12	0	96	89	78	66	51	35	18	0	18	35	51	66	78	89	96	0	12
	10	94	86	76	63	48	32	14	−4	22	39	56	70	83	94	101	10	
	20	94	86	76	62	47	29	11	−8	27	45	62	78	91	102		20	
	30	99	90	78	64	47	28	8	−12	33	53	71	88	103			30	
	40	108	98	84	68	49	28	5	−18	41	63	85	104				40	
	50		112	97	77	54	29	2	−25	53	80	105					50	
	60			120	95	65	33	−1	−37	72	107						60	
	70				134	91	44	−6	−58	110							70	
Declination.	Altitude.	70°	60°	50°	40°	30°	20°	10°	0°	10°	20°	30°	40°	50°	60°	70°	Altitude.	Declination.
		Latitude of same name as declination.								Latitude of different name from declination.								

TABLE 25.

Table showing the variation of the altitude of an object arising from a change of 100 seconds in the declination. Unmarked quantities in the Table are positive. If the change move the body toward the elevated pole, apply the correction to the altitude with the signs in the Table; otherwise, change the signs.

Declination.	Altitude.	Latitude of same name as declination.								Latitude of different name from declination.							Altitude.	Declination.
		70°	60°	50°	40°	30°	20°	10°	0°	10°	20°	30°	40°	50°	60°	70°		
°	°	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	°	°
14	0	97	89	79	66	52	35	18	0	18	35	52	66	79	89	97	0	14
	10	94	86	76	63	48	31	14	−4	23	40	57	72	85	95	103	10	
	20	94	86	75	61	46	27	10	−9	28	45	64	80	93	104		20	
	30	97	89	77	62	45	26	6	−14	35	55	74	91	106			30	
	40	106	96	82	66	46	25	2	−21	44	67	88	107				40	
	50		109	93	73	50	25	−2	−30	58	85	110					50	
	60			115	89	60	27	−7	−43	79	114						60	
	70				125	82	35	−16	−69	121							70	
16	0	98	90	80	67	52	36	18	0	18	36	52	67	80	90	98	0	16
	10	94	86	76	63	48	31	13	−5	23	41	58	73	86	97	104	10	
	20	94	85	74	61	45	27	9	−10	30	48	66	82	95	106		20	
	30	96	87	75	61	44	25	4	−17	37	58	77	94	109			30	
	40	104	94	80	63	44	22	0	−24	48	70	92	111				40	
	50		106	90	70	47	21	−6	−34	62	90	115					50	
	60			110	84	54	21	−14	−50	86	121						60	
	70				117	73	25	−26	−79	132							70	
18	0	99	91	81	68	53	36	18	0	18	36	53	68	81	91	99	0	18
	10	95	87	76	63	48	31	13	−6	24	42	59	74	88	98	106	10	
	20	93	85	74	60	44	26	8	−12	31	50	68	84	98	109		20	
	30	95	86	74	59	42	23	2	−19	40	60	79	97	112			30	
	40	102	92	78	61	41	20	−3	−27	51	74	96	116				40	
	50		103	87	66	43	17	−10	−39	67	95	121					50	
	60			105	79	49	16	−20	−56	93	128						60	
	70				108	64	16	−36	−89	143							70	
20	0	100	92	82	68	53	36	18	0	18	36	53	68	82	92	100	0	20
	10	95	87	76	63	48	31	12	−6	25	43	60	76	89	100		10	
	20	93	85	74	60	43	25	6	−13	33	52	70	86	100			20	
	30	94	85	73	58	40	21	0	−21	42	63	82	100				30	
	40	100	90	76	59	39	17	−6	−31	55	78	100					40	
	50		100	83	63	39	13	−15	−43	72	100						50	
	60			100	74	43	10	−26	−63	100							60	
	70				100	56	6	−46	−100								70	
22	0		93	83	69	54	37	19	0	19	37	54	69	83	93	101	0	22
	10	96	88	77	63	48	30	12	−7	26	45	62	78	91	102		10	
	20	93	85	73	59	43	25	5	−15	35	54	72	88	103			20	
	30	94	85	72	57	39	19	−2	−23	45	66	86	103				30	
	40	98	88	74	57	36	14	−9	−34	58	82	104					40	
	50	110	97	80	60	36	9	−19	−48	77	106						50	
	60		117	95	68	38	4	−33	−70	107							60	
	70			131	92	47	−3	−56	−111								70	
24	0		95	84	70	55	37	19	0	19	37	55	70	84	95	103	0	24
	10	97	88	77	64	48	30	11	−8	27	46	63	79	93	104		10	
	20	93	85	73	59	42	24	4	−16	36	56	74	91	105			20	
	30	93	84	71	56	38	18	−4	−26	48	69	89	107				30	
	40	97	86	72	54	34	12	−12	−37	62	86	109					40	
	50	107	93	77	56	32	5	−23	−53	83	111						50	
	60		112	91	64	32	−2	−39	−77	115							60	
	70			123	83	38	−13	−67	−122								70	
26	0		96	85	72	56	38	19	0	19	38	56	72	85	96	105	0	26
	10	98	89	78	64	48	30	11	−9	28	47	65	81	95	106		10	
	20	95	85	73	59	41	23	3	−18	38	58	77	94	108			20	
	30	93	83	70	54	36	16	−6	−28	50	72	92	111				30	
	40	96	85	70	52	32	9	−16	−41	66	91	114					40	
	50	105	92	74	53	28	1	−28	−58	88	117						50	
	60		108	86	58	27	−8	−46	−84	123							60	
	70			115	75	29	−23	−78	−134								70	
Declination.	Altitude.	70°	60°	50°	40°	30°	20°	10°	0°	10°	20°	30°	40°	50°	60°	70°	Altitude.	Declination.
		Latitude of same name as declination.								Latitude of different name from declination.								

TABLE 26.

Variation of Altitude in one minute from meridian passage.

Latitude.	Declination of the same name as the latitude; upper transit; reduction additive.												Latitude.
	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	
°	″	″	″	″	″	″	″	″	″	″	″	″	°
0					28.1	22.4	18.7	16.0	14.0	12.4	11.1	10.1	0
1						28.0	22.4	18.6	16.0	13.9	12.4	11.1	1
2							28.0	22.3	18.6	15.9	13.9	12.3	2
3								27.9	22.3	18.5	15.8	13.8	3
4	28.1								27.8	22.2	18.5	15.8	4
5	22.4	28.0								27.7	22.1	18.4	5
6	18.7	22.4	28.0								27.6	22.0	6
7	16.0	18.6	22.3	27.9								27.4	7
8	14.0	16.0	18.6	22.3	27.8								8
9	12.4	13.9	15.9	18.5	22.2	27.7							9
10	11.1	12.4	13.9	15.8	18.5	22.1	27.6						10
11	10.1	11.1	12.3	13.8	15.8	18.4	22.0	27.4					11
12	9.2	10.1	11.1	12.3	13.8	15.7	18.3	21.9	27.3				12
13	8.5	9.2	10.0	11.0	12.2	13.7	15.6	18.2	21.7	27.1			13
14	7.9	8.5	9.2	10.0	10.9	12.1	13.6	15.5	18.0	21.6	26.9		14
15	7.3	7.8	8.4	9.1	9.9	10.9	12.1	13.5	15.4	17.9	21.4	26.7	15
16	6.8	7.3	7.8	8.4	9.1	9.8	10.8	12.0	13.4	15.3	17.8	21.3	16
17	6.4	6.8	7.2	7.8	8.3	9.0	9.8	10.7	11.9	13.3	15.2	17.6	17
18	6.0	6.4	6.8	7.2	7.7	8.3	8.9	9.7	10.6	11.8	13.2	15.0	18
19	5.7	6.0	6.3	6.7	7.2	7.6	8.2	8.9	9.6	10.6	11.7	13.1	19
20	5.4	5.7	6.0	6.3	6.7	7.1	7.6	8.1	8.8	9.5	10.5	11.6	20
21	5.1	5.4	5.6	5.9	6.3	6.6	7.0	7.5	8.1	8.7	9.5	10.4	21
22	4.9	5.1	5.3	5.6	5.9	6.2	6.6	7.0	7.5	8.0	8.6	9.4	22
23	4.6	4.8	5.0	5.3	5.5	5.8	6.1	6.5	6.9	7.4	7.9	8.5	23
24	4.4	4.6	4.8	5.0	5.2	5.5	5.8	6.1	6.4	6.8	7.3	7.8	24
25	4.2	4.4	4.6	4.7	5.0	5.2	5.4	5.7	6.0	6.4	6.8	7.2	25
26	4.0	4.2	4.3	4.5	4.7	4.9	5.1	5.4	5.7	6.0	6.3	6.7	26
27	3.9	4.0	4.1	4.3	4.5	4.7	4.9	5.1	5.3	5.6	5.9	6.2	27
28	3.7	3.8	4.0	4.1	4.3	4.4	4.6	4.8	5.0	5.3	5.5	5.8	28
29	3.5	3.7	3.8	3.9	4.1	4.2	4.4	4.6	4.7	5.0	5.2	5.5	29
30	3.4	3.5	3.6	3.7	3.9	4.0	4.2	4.3	4.5	4.7	4.9	5.1	30
31	3.3	3.4	3.5	3.6	3.7	3.8	4.0	4.1	4.3	4.4	4.6	4.8	31
32	3.1	3.2	3.3	3.4	3.5	3.7	3.8	3.9	4.1	4.2	4.4	4.6	32
33	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.9	4.0	4.2	4.3	33
34	2.9	3.0	3.1	3.2	3.2	3.3	3.4	3.6	3.7	3.8	3.9	4.1	34
35	2.8	2.9	3.0	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.9	35
36	2.7	2.8	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	36
37	2.6	2.7	2.7	2.8	2.9	2.9	3.0	3.1	3.2	3.3	3.4	3.5	37
38	2.5	2.6	2.6	2.7	2.8	2.8	2.9	3.0	3.0	3.2	3.2	3.3	38
39	2.4	2.5	2.5	2.6	2.7	2.7	2.8	2.9	2.9	3.0	3.1	3.2	39
40	2.3	2.4	2.4	2.5	2.6	2.6	2.7	2.7	2.8	2.9	3.0	3.0	40
41	2.3	2.3	2.4	2.4	2.5	2.5	2.6	2.6	2.7	2.8	2.8	2.9	41
42	2.2	2.2	2.3	2.3	2.4	2.4	2.5	2.5	2.6	2.6	2.7	2.8	42
43	2.1	2.1	2.2	2.2	2.3	2.3	2.4	2.4	2.5	2.5	2.6	2.7	43
44	2.0	2.1	2.1	2.1	2.2	2.2	2.3	2.3	2.4	2.4	2.5	2.5	44
45	2.0	2.0	2.0	2.1	2.1	2.2	2.2	2.2	2.3	2.3	2.4	2.4	45
46	1.9	1.9	2.0	2.0	2.0	2.1	2.1	2.2	2.2	2.2	2.3	2.3	46
47	1.8	1.9	1.9	1.9	2.0	2.0	2.0	2.1	2.1	2.1	2.2	2.2	47
48	1.8	1.8	1.8	1.9	1.9	1.9	2.0	2.0	2.0	2.1	2.1	2.1	48
49	1.7	1.7	1.8	1.8	1.8	1.8	1.9	1.9	1.9	2.0	2.0	2.1	49
50	1.6	1.7	1.7	1.7	1.8	1.8	1.8	1.8	1.9	1.9	1.9	2.0	50
51	1.6	1.6	1.6	1.7	1.7	1.7	1.7	1.8	1.8	1.8	1.9	1.9	51
52	1.5	1.6	1.6	1.6	1.6	1.6	1.7	1.7	1.7	1.8	1.8	1.8	52
53	1.5	1.5	1.5	1.5	1.6	1.6	1.6	1.6	1.7	1.7	1.7	1.7	53
54	1.4	1.4	1.5	1.5	1.5	1.5	1.5	1.6	1.6	1.6	1.6	1.7	54
55	1.4	1.4	1.4	1.4	1.5	1.5	1.5	1.5	1.5	1.6	1.6	1.6	55
56	1.3	1.3	1.4	1.4	1.4	1.4	1.4	1.4	1.5	1.5	1.5	1.5	56
57	1.3	1.3	1.3	1.3	1.3	1.4	1.4	1.4	1.4	1.4	1.4	1.5	57
58	1.2	1.2	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.4	1.4	1.4	58
59	1.2	1.2	1.2	1.2	1.2	1.3	1.3	1.3	1.3	1.3	1.3	1.3	59
60	1.1	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.3	1.3	60
	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	
	Declination of the same name as the latitude; upper transit; reduction additive.												

TABLE 26.

Variation of Altitude in one minute from meridian passage.

Latitude.	Declination of the same name as the latitude; upper transit; reduction additive.													Latitude.
	12°	13°	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	24°	
°	″	″	″	″	″	″	″	″	″	″	″	″	″	°
0	9.2	8.5	7.9	7.3	6.8	6.4	6.0	5.7	5.4	5.1	4.9	4.6	4.4	0
1	10.1	9.2	8.5	7.8	7.3	6.8	6.4	6.0	5.7	5.4	5.1	4.8	4.6	1
2	11.1	10.0	9.2	8.4	7.8	7.2	6.8	6.3	6.0	5.6	5.3	5.0	4.8	2
3	12.3	11.0	10.0	9.1	8.4	7.8	7.2	6.7	6.3	5.9	5.6	5.3	5.0	3
4	13.8	12.2	10.9	9.9	9.1	8.3	7.7	7.2	6.7	6.3	5.9	5.5	5.2	4
5	15.7	13.7	12.1	10.9	9.8	9.0	8.3	7.6	7.1	6.6	6.2	5.8	5.5	5
6	18.3	15.6	13.6	12.1	10.8	9.8	8.9	8.2	7.6	7.0	6.6	6.1	5.8	6
7	21.9	18.2	15.5	13.5	12.0	10.7	9.7	8.9	8.1	7.5	7.0	6.5	6.1	7
8	27.3	21.7	18.0	15.4	13.4	11.9	10.6	9.6	8.8	8.1	7.5	6.9	6.4	8
9		27.1	21.6	17.9	15.3	13.3	11.8	10.6	9.5	8.7	8.0	7.4	6.8	9
10			26.9	21.4	17.8	15.2	13.2	11.7	10.5	9.5	8.6	7.9	7.3	10
11				26.7	21.3	17.6	15.0	13.1	11.6	10.4	9.4	8.5	7.8	11
12					26.5	21.1	17.5	14.9	13.0	11.5	10.3	9.3	8.4	12
13						26.2	20.9	17.3	14.8	12.8	11.3	10.1	9.2	13
14							26.0	20.7	17.1	14.6	12.7	11.2	10.0	14
15								25.7	20.4	16.9	14.4	12.5	11.1	15
16	26.5								25.4	20.2	16.7	14.3	12.4	16
17	21.1	26.2								25.1	20.0	16.5	14.1	17
18	17.5	20.9	26.0								24.8	19.7	16.3	18
19	14.9	17.3	20.7	25.7								24.5	19.5	19
20	13.0	14.8	17.1	20.4	25.4								24.2	20
21	11.5	12.8	14.6	16.9	20.2	25.1								21
22	10.3	11.8	12.7	14.4	16.7	20.0	24.8							22
23	9.3	10.1	11.2	12.5	14.8	16.5	19.7	24.5						23
24	8.4	9.2	10.0	11.1	12.4	14.1	16.3	19.5	24.2					24
25	7.7	8.3	9.0	9.9	10.9	12.2	13.9	16.1	19.2	23.8				25
26	7.1	7.6	8.2	8.9	9.8	10.8	12.1	13.7	15.9	18.9	23.5			26
27	6.6	7.0	7.5	8.1	8.8	9.6	10.6	11.9	13.5	15.6	18.6	23.1		27
28	6.2	6.5	7.0	7.4	8.0	8.7	9.5	10.5	11.7	13.3	15.4	18.3	22.7	28
29	5.7	6.1	6.4	6.9	7.3	7.9	8.6	9.4	10.3	11.5	13.1	15.1	18.0	29
30	5.4	5.7	6.0	6.4	6.8	7.2	7.8	8.4	9.2	10.1	11.3	12.8	14.9	30
31	5.1	5.3	5.6	5.9	6.3	6.7	7.1	7.7	8.3	9.0	10.0	11.1	12.6	31
32	4.8	5.0	5.2	5.5	5.8	6.2	6.5	7.0	7.5	8.1	8.9	9.8	10.9	32
33	4.5	4.7	4.9	5.1	5.4	5.7	6.1	6.4	6.9	7.4	8.0	8.7	9.6	33
34	4.3	4.4	4.6	4.8	5.1	5.3	5.6	5.9	6.3	6.8	7.3	7.8	8.6	34
35	4.0	4.2	4.4	4.5	4.7	5.0	5.2	5.5	5.8	6.2	6.6	7.1	7.7	35
36	3.8	4.0	4.1	4.3	4.5	4.7	4.9	5.1	5.4	5.7	6.1	6.5	7.0	36
37	3.6	3.8	3.9	4.0	4.2	4.4	4.6	4.8	5.0	5.3	5.6	6.0	6.4	37
38	3.4	3.6	3.7	3.8	4.0	4.1	4.3	4.5	4.7	4.9	5.2	5.5	5.8	38
39	3.3	3.4	3.5	3.6	3.8	3.9	4.0	4.2	4.4	4.6	4.8	5.1	5.4	39
40	3.1	3.2	3.3	3.4	3.6	3.7	3.8	4.0	4.1	4.3	4.5	4.7	5.0	40
41	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.9	4.0	4.2	4.4	4.6	41
42	2.9	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.7	3.8	4.0	4.1	4.3	42
43	2.7	2.8	2.9	3.0	3.0	3.1	3.2	3.3	3.5	3.6	3.7	3.9	4.0	43
44	2.6	2.7	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.8	44
45	2.5	2.6	2.6	2.7	2.8	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	45
46	2.4	2.4	2.5	2.6	2.6	2.7	2.8	2.8	2.9	3.0	3.1	3.2	3.3	46
47	2.3	2.3	2.4	2.4	2.5	2.6	2.6	2.7	2.8	2.9	2.9	3.0	3.1	47
48	2.2	2.2	2.3	2.3	2.4	2.4	2.5	2.6	2.6	2.7	2.8	2.9	3.0	48
49	2.1	2.1	2.2	2.2	2.3	2.3	2.4	2.4	2.5	2.6	2.6	2.7	2.8	49
50	2.0	2.0	2.1	2.1	2.2	2.2	2.3	2.3	2.4	2.4	2.5	2.6	2.6	50
51	1.9	2.0	2.0	2.0	2.1	2.1	2.2	2.2	2.3	2.3	2.4	2.4	2.5	51
52	1.8	1.9	1.9	1.9	2.0	2.0	2.1	2.1	2.1	2.2	2.2	2.3	2.4	52
53	1.8	1.8	1.8	1.9	1.9	1.9	2.0	2.0	2.0	2.1	2.1	2.2	2.2	53
54	1.7	1.7	1.7	1.8	1.8	1.8	1.9	1.9	1.9	2.0	2.0	2.1	2.1	54
55	1.6	1.6	1.7	1.7	1.7	1.8	1.8	1.8	1.9	1.9	1.9	2.0	2.0	55
56	1.5	1.6	1.6	1.6	1.6	1.7	1.7	1.7	1.8	1.8	1.8	1.9	1.9	56
57	1.5	1.5	1.5	1.5	1.6	1.6	1.6	1.6	1.7	1.7	1.7	1.8	1.8	57
58	1.4	1.4	1.5	1.5	1.5	1.5	1.5	1.6	1.6	1.6	1.6	1.7	1.7	58
59	1.4	1.4	1.4	1.4	1.4	1.5	1.5	1.5	1.5	1.5	1.6	1.6	1.6	59
60	1.3	1.3	1.3	1.3	1.4	1.4	1.4	1.4	1.4	1.5	1.5	1.5	1.5	60
	12°	13°	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	24°	
	Declination of the same name as the latitude; upper transit; reduction additive.													

TABLE 26.

Variation of Altitude in one minute from meridian passage.

Latitude.	Declination of the same name as the latitude; upper transit; reduction additive.													Latitude.
	25°	26°	27°	28°	29°	30°	31°	32°	33°	34°	35°	36°	37°	
°	″	″	″	″	″	″	″	″	″	″	″	″	″	°
0	4.2	4.0	3.9	3.7	3.5	3.4	3.3	3.1	3.0	2.9	2.8	2.7	2.6	0
1	4.4	4.2	4.0	3.8	3.7	3.5	3.4	3.2	3.1	3.0	2.9	2.8	2.7	1
2	4.6	4.3	4.1	4.0	3.8	3.6	3.5	3.3	3.2	3.1	3.0	2.8	2.7	2
3	4.7	4.5	4.3	4.1	3.9	3.7	3.6	3.4	3.3	3.2	3.0	2.9	2.8	3
4	5.0	4.7	4.5	4.3	4.1	3.9	3.7	3.5	3.4	3.3	3.1	3.0	2.9	4
5	5.2	4.9	4.7	4.4	4.2	4.0	3.8	3.7	3.5	3.3	3.2	3.1	3.0	5
6	5.4	5.1	4.9	4.6	4.4	4.2	4.0	3.8	3.6	3.5	3.3	3.2	3.0	6
7	5.7	5.4	5.1	4.8	4.6	4.3	4.1	3.9	3.7	3.6	3.4	3.3	3.1	7
8	6.0	5.7	5.3	5.0	4.8	4.5	4.3	4.1	3.9	3.7	3.5	3.4	3.2	8
9	6.4	6.0	5.6	5.3	5.0	4.7	4.4	4.2	4.0	3.8	3.6	3.5	3.3	9
10	6.8	6.3	5.9	5.5	5.2	4.9	4.6	4.4	4.2	3.9	3.8	3.6	3.4	10
11	7.2	6.7	6.2	5.8	5.5	5.1	4.8	4.6	4.3	4.1	3.9	3.7	3.5	11
12	7.7	7.1	6.6	6.2	5.8	5.4	5.1	4.8	4.5	4.3	4.0	3.8	3.6	12
13	8.3	7.6	7.1	6.5	6.1	5.7	5.3	5.0	4.7	4.4	4.2	4.0	3.8	13
14	9.1	8.2	7.6	7.0	6.4	6.0	5.6	5.2	4.9	4.6	4.4	4.1	3.9	14
15	9.9	8.9	8.1	7.4	6.9	6.4	5.9	5.5	5.2	4.8	4.5	4.3	4.0	15
16	10.9	9.8	8.8	8.0	7.3	6.8	6.3	5.8	5.4	5.1	4.8	4.5	4.2	16
17	12.2	10.8	9.6	8.7	7.9	7.2	6.7	6.2	5.7	5.3	5.0	4.7	4.4	17
18	13.9	12.1	10.6	9.5	8.6	7.8	7.1	6.6	6.1	5.6	5.2	4.9	4.6	18
19	16.1	13.7	11.9	10.5	9.4	8.4	7.7	7.0	6.4	6.0	5.5	5.1	4.8	19
20	19.2	15.9	13.5	11.7	10.3	9.2	8.3	7.5	6.9	6.3	5.8	5.4	5.0	20
21	23.8	18.9	15.6	13.3	11.5	10.2	9.1	8.2	7.4	6.8	6.2	5.7	5.3	21
22		23.5	18.6	15.4	13.1	11.3	10.0	8.9	8.0	7.3	6.6	6.1	5.6	22
23			23.1	18.3	15.1	12.8	11.1	9.8	8.7	7.9	7.1	6.5	6.0	23
24				22.7	18.0	14.9	12.6	10.9	9.6	8.6	7.7	7.0	6.4	24
25					22.3	17.7	14.6	12.4	10.7	9.4	8.4	7.5	6.8	25
26						21.9	17.4	14.3	12.1	10.5	9.2	8.2	7.4	26
27							21.5	17.0	14.0	11.9	10.3	9.1	8.1	27
28								21.1	16.7	13.8	11.7	10.1	8.9	28
29	22.3								20.6	16.3	13.5	11.4	9.9	29
30	17.7	21.9								20.2	16.0	13.2	11.1	30
31	14.6	17.4	21.5								19.8	15.6	12.9	31
32	12.4	14.3	17.0	21.1								19.3	15.3	32
33	10.7	12.1	14.0	16.7	20.6								18.9	33
34	9.4	10.5	11.9	13.8	16.3	20.2								34
35	8.4	9.2	10.3	11.7	13.5	16.0	19.8							35
36	7.5	8.2	9.1	10.1	11.4	13.2	15.6	19.3						36
37	6.8	7.4	8.1	8.9	9.9	11.1	12.9	15.3	18.9					37
38	6.2	6.7	7.2	7.9	8.7	9.6	10.9	12.6	14.9	18.4				38
39	5.7	6.1	6.5	7.1	7.7	8.5	9.4	10.6	12.2	14.5	17.9			39
40	5.3	5.6	6.0	6.4	6.9	7.5	8.2	9.2	10.4	11.9	14.1	17.4		40
41	4.9	5.2	5.5	5.8	6.2	6.7	7.3	8.0	8.9	10.1	11.6	13.8	17.0	41
42	4.5	4.8	5.0	5.3	5.7	6.1	6.6	7.1	7.8	8.7	9.8	11.3	13.4	42
43	4.2	4.4	4.6	4.9	5.2	5.5	5.9	6.4	6.9	7.6	8.5	9.5	11.0	43
44	3.9	4.1	4.3	4.5	4.8	5.1	5.4	5.8	6.2	6.7	7.4	8.2	9.3	44
45	3.7	3.8	4.0	4.2	4.4	4.7	4.9	5.2	5.6	6.0	6.6	7.2	8.0	45
46	3.5	3.6	3.7	3.9	4.1	4.3	4.5	4.8	5.1	5.4	5.9	6.4	7.0	46
47	3.3	3.4	3.5	3.6	3.8	4.0	4.2	4.4	4.6	4.9	5.3	5.7	6.2	47
48	3.1	3.2	3.3	3.4	3.5	3.7	3.9	4.0	4.3	4.5	4.8	5.1	5.5	48
49	2.9	3.0	3.1	3.2	3.3	3.4	3.6	3.7	3.9	4.1	4.4	4.6	5.0	49
50	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.5	3.6	3.8	4.0	4.2	4.5	50
51	2.6	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.4	3.5	3.7	3.9	4.1	51
52	2.4	2.5	2.6	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.4	3.6	3.7	52
53	2.3	2.3	2.4	2.5	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.3	3.4	53
54	2.2	2.2	2.3	2.3	2.4	2.5	2.5	2.6	2.7	2.8	2.9	3.0	3.2	54
55	2.0	2.1	2.1	2.2	2.3	2.3	2.4	2.4	2.5	2.6	2.7	2.8	2.9	55
56	1.9	2.0	2.0	2.1	2.1	2.2	2.2	2.3	2.4	2.4	2.5	2.6	2.7	56
57	1.8	1.9	1.9	2.0	2.0	2.0	2.1	2.2	2.2	2.3	2.3	2.4	2.5	57
58	1.7	1.8	1.8	1.8	1.9	1.9	2.0	2.0	2.1	2.1	2.2	2.3	2.3	58
59	1.6	1.7	1.7	1.7	1.8	1.8	1.9	1.9	1.9	2.0	2.0	2.1	2.2	59
60	1.6	1.6	1.6	1.6	1.7	1.7	1.7	1.8	1.8	1.9	1.9	2.0	2.0	60
	25°	26°	27°	28°	29°	30°	31°	32°	33°	34°	35°	36°	37°	
	Declination of the same name as the latitude; upper transit; reduction additive.													

TABLE 26.

Variation of Altitude in one minute from meridian passage.

Latitude.	Declination of the same name as the latitude; upper transit; reduction additive.													Latitude.
	38°	39°	40°	41°	42°	43°	44°	45°	46°	47°	48°	49°	50°	
°	″	″	″	″	″	″	″	″	″	″	″	″	″	°
0	2.5	2.4	2.3	2.3	2.2	2.1	2.0	2.0	1.9	1.8	1.8	1.7	1.7	0
1	2.6	2.5	2.4	2.3	2.2	2.2	2.1	2.0	1.9	1.9	1.8	1.7	1.7	1
2	2.6	2.5	2.4	2.4	2.3	2.2	2.1	2.0	2.0	1.9	1.8	1.8	1.7	2
3	2.7	2.6	2.5	2.4	2.3	2.2	2.2	2.1	2.0	1.9	1.9	1.8	1.7	3
4	2.8	2.7	2.6	2.5	2.4	2.3	2.2	2.1	2.0	2.0	1.9	1.8	1.8	4
5	2.8	2.7	2.6	2.5	2.4	2.3	2.2	2.2	2.1	2.0	1.9	1.9	1.8	5
6	2.9	2.8	2.7	2.6	2.5	2.4	2.3	2.2	2.1	2.0	2.0	1.9	1.8	6
7	3.0	2.9	2.7	2.6	2.5	2.4	2.3	2.2	2.2	2.1	2.0	1.9	1.8	7
8	3.1	2.9	2.8	2.7	2.6	2.5	2.4	2.3	2.2	2.1	2.0	1.9	1.9	8
9	3.2	3.0	2.9	2.8	2.7	2.5	2.4	2.3	2.2	2.2	2.1	2.0	1.9	9
10	3.3	3.1	3.0	2.8	2.7	2.6	2.5	2.4	2.3	2.2	2.1	2.0	1.9	10
11	3.4	3.2	3.1	2.9	2.8	2.7	2.6	2.4	2.3	2.2	2.1	2.1	2.0	11
12	3.5	3.3	3.1	3.0	2.9	2.7	2.6	2.5	2.4	2.3	2.2	2.1	2.0	12
13	3.6	3.4	3.2	3.1	2.9	2.8	2.7	2.6	2.4	2.3	2.2	2.1	2.0	13
14	3.7	3.5	3.3	3.2	3.0	2.9	2.7	2.6	2.5	2.4	2.3	2.2	2.1	14
15	3.8	3.6	3.4	3.3	3.1	3.0	2.8	2.7	2.6	2.4	2.3	2.2	2.1	15
16	4.0	3.8	3.6	3.4	3.2	3.0	2.9	2.8	2.6	2.5	2.4	2.3	2.2	16
17	4.1	3.9	3.7	3.5	3.3	3.1	3.0	2.8	2.7	2.6	2.4	2.3	2.2	17
18	4.3	4.1	3.8	3.6	3.4	3.2	3.1	2.9	2.8	2.6	2.5	2.4	2.3	18
19	4.5	4.2	4.0	3.7	3.5	3.3	3.2	3.0	2.8	2.7	2.6	2.4	2.3	19
20	4.7	4.4	4.1	3.9	3.7	3.5	3.3	3.1	2.9	2.8	2.6	2.5	2.4	20
21	4.9	4.6	4.3	4.0	3.8	3.6	3.4	3.2	3.0	2.9	2.7	2.6	2.4	21
22	5.2	4.8	4.5	4.2	4.0	3.7	3.5	3.3	3.1	2.9	2.8	2.6	2.5	22
23	5.5	5.1	4.7	4.4	4.1	3.9	3.6	3.4	3.2	3.0	2.9	2.7	2.6	23
24	5.8	5.4	5.0	4.6	4.3	4.0	3.8	3.5	3.3	3.1	3.0	2.8	2.6	24
25	6.2	5.7	5.3	4.9	4.5	4.2	3.9	3.7	3.5	3.3	3.1	2.9	2.7	25
26	6.7	6.1	5.6	5.2	4.8	4.4	4.1	3.8	3.6	3.4	3.2	3.0	2.8	26
27	7.2	6.5	6.0	5.5	5.0	4.6	4.3	4.0	3.7	3.5	3.3	3.1	2.9	27
28	7.9	7.1	6.4	5.8	5.3	4.9	4.5	4.2	3.9	3.6	3.4	3.2	3.0	28
29	8.7	7.7	6.9	6.2	5.7	5.2	4.8	4.4	4.1	3.8	3.5	3.3	3.1	29
30	9.6	8.5	7.5	6.7	6.1	5.5	5.1	4.7	4.3	4.0	3.7	3.4	3.2	30
31	10.9	9.4	8.2	7.3	6.6	5.9	5.4	4.9	4.5	4.2	3.9	3.6	3.3	31
32	12.6	10.6	9.2	8.0	7.1	6.4	5.8	5.2	4.8	4.4	4.0	3.7	3.5	32
33	14.9	12.2	10.4	8.9	7.8	6.9	6.2	5.6	5.1	4.6	4.3	3.9	3.6	33
34	18.4	14.5	11.9	10.1	8.7	7.6	6.7	6.0	5.4	4.9	4.5	4.1	3.8	34
35		17.9	14.1	11.6	9.8	8.5	7.4	6.6	5.9	5.3	4.8	4.4	4.0	35
36			17.4	13.8	11.3	9.5	8.2	7.2	6.4	5.7	5.1	4.6	4.2	36
37				17.0	13.4	11.0	9.3	8.0	7.0	6.2	5.5	5.0	4.5	37
38					16.5	13.0	10.7	9.0	7.7	6.8	6.0	5.3	4.8	38
39						16.0	12.6	10.3	8.7	7.5	6.5	5.8	5.1	39
40							15.5	12.2	10.0	8.4	7.2	6.3	5.6	40
41								15.0	11.8	9.7	8.1	7.0	6.1	41
42	16.5								14.5	11.4	9.3	7.9	6.7	42
43	13.0	16.0								14.0	11.0	9.0	7.6	43
44	10.7	12.6	15.5								13.6	10.6	8.7	44
45	9.0	10.3	12.2	15.0								13.1	10.2	45
46	7.7	8.7	10.0	11.8	14.5								12.6	46
47	6.8	7.5	8.4	9.7	11.4	14.0								47
48	6.0	6.5	7.2	8.1	9.3	11.0	13.6							48
49	5.3	5.8	6.3	7.0	7.9	9.0	10.6	13.1						49
50	4.8	5.1	5.6	6.1	6.7	7.6	8.7	10.2	12.6					50
51	4.3	4.6	5.0	5.4	5.9	6.5	7.3	8.4	9.9	12.1				51
52	3.9	4.2	4.5	4.8	5.2	5.7	6.3	7.0	8.0	9.5	11.6			52
53	3.6	3.8	4.0	4.3	4.6	5.0	5.4	6.0	6.7	7.7	9.1	11.1		53
54	3.3	3.5	3.7	3.9	4.1	4.4	4.8	5.2	5.8	6.5	7.4	8.7	10.6	54
55	3.0	3.2	3.3	3.5	3.7	4.0	4.3	4.6	5.0	5.5	6.2	7.1	8.3	55
56	2.8	2.9	3.1	3.2	3.4	3.6	3.8	4.1	4.4	4.8	5.3	5.9	6.8	56
57	2.6	2.7	2.8	2.9	3.1	3.2	3.4	3.6	3.9	4.2	4.6	5.0	5.6	57
58	2.4	2.5	2.6	2.7	2.8	2.9	3.1	3.3	3.5	3.7	4.0	4.4	4.8	58
59	2.2	2.3	2.4	2.5	2.6	2.7	2.8	3.0	3.1	3.3	3.6	3.8	4.2	59
60	2.1	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	3.0	3.2	3.4	3.6	60
	38°	39°	40°	41°	42°	43°	44°	45°	46°	47°	48°	49°	50°	
	Declination of the same name as the latitude; upper transit; reduction additive.													

TABLE 26.

Variation of Altitude in one minute from meridian passage.

Latitude.	Declination of the same name as the latitude; upper transit; reduction additive.													Latitude.
	51°	52°	53°	54°	55°	56°	57°	58°	59°	60°	61°	62°	63°	
°	″	″	″	″	″	″	″	″	″	″	″	″	″	°
0	1.6	1.5	1.5	1.4	1.4	1.3	1.3	1.2	1.2	1.1	1.1	1.0	1.0	0
1	1.6	1.6	1.5	1.4	1.4	1.3	1.3	1.2	1.2	1.2	1.1	1.1	1.0	1
2	1.6	1.6	1.5	1.5	1.4	1.4	1.3	1.3	1.2	1.2	1.1	1.1	1.0	2
3	1.7	1.6	1.5	1.5	1.4	1.4	1.3	1.3	1.2	1.2	1.1	1.1	1.0	3
4	1.7	1.6	1.6	1.5	1.5	1.4	1.3	1.3	1.2	1.2	1.1	1.1	1.0	4
5	1.7	1.7	1.6	1.5	1.5	1.4	1.4	1.3	1.3	1.2	1.1	1.1	1.1	5
6	1.7	1.7	1.6	1.5	1.5	1.4	1.4	1.3	1.3	1.2	1.2	1.1	1.1	6
7	1.8	1.7	1.6	1.6	1.5	1.4	1.4	1.3	1.3	1.2	1.2	1.1	1.1	7
8	1.8	1.7	1.7	1.6	1.5	1.5	1.4	1.4	1.3	1.2	1.2	1.1	1.1	8
9	1.8	1.8	1.7	1.6	1.6	1.5	1.4	1.4	1.3	1.3	1.2	1.1	1.1	9
10	1.9	1.8	1.7	1.6	1.6	1.5	1.4	1.4	1.3	1.3	1.2	1.2	1.1	10
11	1.9	1.8	1.7	1.7	1.6	1.5	1.5	1.4	1.3	1.3	1.2	1.2	1.1	11
12	1.9	1.8	1.8	1.7	1.6	1.6	1.5	1.4	1.4	1.3	1.2	1.2	1.1	12
13	2.0	1.9	1.8	1.7	1.6	1.6	1.5	1.4	1.4	1.3	1.3	1.2	1.1	13
14	2.0	1.9	1.8	1.7	1.7	1.6	1.5	1.5	1.4	1.3	1.3	1.2	1.2	14
15	2.0	1.9	1.9	1.8	1.7	1.6	1.5	1.5	1.4	1.3	1.3	1.2	1.2	15
16	2.1	2.0	1.9	1.8	1.7	1.6	1.6	1.5	1.4	1.4	1.3	1.2	1.2	16
17	2.1	2.0	1.9	1.8	1.8	1.7	1.6	1.5	1.5	1.4	1.3	1.3	1.2	17
18	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.5	1.4	1.3	1.3	1.2	18
19	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.6	1.5	1.4	1.4	1.3	1.2	19
20	2.3	2.1	2.0	1.9	1.9	1.8	1.7	1.6	1.5	1.4	1.4	1.3	1.2	20
21	2.3	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.5	1.4	1.3	1.2	21
22	2.4	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.6	1.5	1.4	1.3	1.3	22
23	2.4	2.3	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.4	1.3	23
24	2.5	2.4	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.5	1.4	1.3	24
25	2.6	2.4	2.3	2.2	2.0	1.9	1.8	1.7	1.6	1.6	1.5	1.4	1.3	25
26	2.6	2.5	2.3	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.3	26
27	2.7	2.6	2.4	2.3	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.4	27
28	2.8	2.6	2.5	2.3	2.2	2.1	2.0	1.8	1.7	1.6	1.5	1.5	1.4	28
29	2.9	2.7	2.5	2.4	2.3	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.4	29
30	3.0	2.8	2.6	2.5	2.3	2.2	2.0	1.9	1.8	1.7	1.6	1.5	1.4	30
31	3.1	2.9	2.7	2.5	2.4	2.2	2.1	2.0	1.9	1.7	1.6	1.5	1.4	31
32	3.2	3.0	2.8	2.6	2.4	2.3	2.2	2.0	1.9	1.8	1.7	1.6	1.5	32
33	3.4	3.1	2.9	2.7	2.5	2.4	2.2	2.1	1.9	1.8	1.7	1.6	1.5	33
34	3.5	3.2	3.0	2.8	2.6	2.4	2.3	2.1	2.0	1.9	1.7	1.6	1.5	34
35	3.7	3.4	3.1	2.9	2.7	2.5	2.3	2.2	2.0	1.9	1.8	1.7	1.6	35
36	3.9	3.6	3.3	3.0	2.8	2.6	2.4	2.3	2.1	2.0	1.8	1.7	1.6	36
37	4.1	3.7	3.4	3.2	2.9	2.7	2.5	2.3	2.2	2.0	1.9	1.7	1.6	37
38	4.3	3.9	3.6	3.3	3.0	2.8	2.6	2.4	2.2	2.1	1.9	1.8	1.7	38
39	4.6	4.2	3.8	3.5	3.2	2.9	2.7	2.5	2.3	2.1	2.0	1.8	1.7	39
40	5.0	4.5	4.0	3.7	3.3	3.1	2.8	2.6	2.4	2.2	2.0	1.9	1.8	40
41	5.4	4.8	4.3	3.9	3.5	3.2	2.9	2.7	2.5	2.3	2.1	1.9	1.8	41
42	5.9	5.2	4.6	4.1	3.7	3.4	3.1	2.8	2.6	2.4	2.2	2.0	1.9	42
43	6.5	5.7	5.0	4.4	4.0	3.6	3.2	2.9	2.7	2.5	2.3	2.1	1.9	43
44	7.3	6.3	5.4	4.8	4.3	3.8	3.4	3.1	2.8	2.6	2.3	2.2	2.0	44
45	8.4	7.0	6.0	5.2	4.6	4.1	3.6	3.3	3.0	2.7	2.4	2.2	2.0	45
46	9.9	8.0	6.7	5.8	5.0	4.4	3.9	3.5	3.1	2.8	2.6	2.3	2.1	46
47	12.1	9.5	7.7	6.5	5.5	4.8	4.2	3.7	3.3	3.0	2.7	2.4	2.2	47
48		11.6	9.1	7.4	6.2	5.3	4.6	4.0	3.6	3.2	2.8	2.6	2.3	48
49			11.1	8.7	7.1	5.9	5.0	4.4	3.8	3.4	3.0	2.7	2.4	49
50				10.6	8.3	6.8	5.6	4.8	4.2	3.6	3.2	2.9	2.6	50
51					10.2	7.9	6.4	5.4	4.6	4.0	3.5	3.0	2.7	51
52						9.7	7.6	6.1	5.1	4.3	3.8	3.3	2.9	52
53							9.2	7.2	5.9	4.9	4.1	3.6	3.1	53
54								8.8	6.8	5.5	4.6	3.9	3.4	54
55	10.2								8.3	6.5	5.3	4.3	3.7	55
56	7.9	9.7								7.9	6.1	5.0	4.1	56
57	6.4	7.6	9.2								7.4	5.8	4.7	57
58	5.4	6.1	7.2	8.8								7.0	5.4	58
59	4.6	5.1	5.9	6.8	8.3								6.6	59
60	4.0	4.3	4.9	5.5	6.5	7.9								60
	51°	52°	53°	54°	55°	56°	57°	58°	59°	60°	61°	62°	63°	
	Declination of the same name as the latitude; upper transit; reduction additive.													

TABLE 26.

Variation of Altitude in one minute from meridian passage.

Latitude.	Declination of a different name from the latitude; upper transit; reduction additive.												Latitude.
	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	
°	″	″	″	″	″	″	″	″	″	″	″	″	°
0					28.1	22.4	18.7	16.0	14.0	12.4	11.1	10.1	0
1				28.1	22.4	18.7	16.0	14.0	12.4	11.2	10.1	9.3	1
2			28.1	22.4	18.7	16.0	14.0	12.5	11.2	10.2	9.3	8.6	2
3		28.1	22.4	18.7	16.0	14.0	12.5	11.2	10.2	9.3	8.6	8.0	3
4	28.1	22.4	18.7	16.0	14.0	12.5	11.2	10.2	9.3	8.6	8.0	7.4	4
5	22.4	18.7	16.0	14.0	12.5	11.2	10.2	9.3	8.6	8.0	7.4	7.0	5
6	18.7	16.0	14.0	12.5	11.2	10.2	9.3	8.6	8.0	7.5	7.0	6.6	6
7	16.0	14.0	12.4	11.2	10.2	9.3	8.6	8.0	7.5	7.0	6.6	6.2	7
8	14.0	12.4	11.2	10.2	9.3	8.6	8.0	7.5	7.0	6.6	6.2	5.9	8
9	12.4	11.2	10.2	9.3	8.6	8.0	7.5	7.0	6.6	6.2	5.9	5.6	9
10	11.1	10.1	9.3	8.6	8.0	7.4	7.0	6.6	6.2	5.9	5.6	5.3	10
11	10.1	9.3	8.6	8.0	7.4	7.0	6.6	6.2	5.9	5.6	5.3	5.1	11
12	9.2	8.5	7.9	7.4	7.0	6.5	6.2	5.9	5.6	5.3	5.0	4.8	12
13	8.5	7.9	7.4	6.9	6.5	6.2	5.8	5.6	5.3	5.0	4.8	4.6	13
14	7.9	7.4	6.9	6.5	6.2	5.8	5.5	5.3	5.0	4.8	4.6	4.4	14
15	7.3	6.9	6.5	6.1	5.8	5.5	5.3	5.0	4.8	4.6	4.4	4.2	15
16	6.8	6.5	6.1	5.8	5.5	5.2	5.0	4.8	4.6	4.4	4.2	4.1	16
17	6.4	6.1	5.8	5.5	5.2	5.0	4.8	4.6	4.4	4.2	4.1	3.9	17
18	6.0	5.7	5.5	5.2	5.0	4.8	4.6	4.4	4.2	4.1	3.9	3.8	18
19	5.7	5.4	5.2	4.9	4.7	4.5	4.4	4.2	4.0	3.9	3.8	3.6	19
20	5.4	5.1	4.9	4.7	4.5	4.3	4.2	4.0	3.9	3.8	3.6	3.5	20
21	5.1	4.9	4.7	4.5	4.3	4.2	4.0	3.9	3.7	3.6	3.5	3.4	21
22	4.9	4.7	4.5	4.3	4.1	4.0	3.9	3.7	3.6	3.5	3.4	3.3	22
23	4.6	4.4	4.3	4.1	4.0	3.8	3.7	3.6	3.5	3.4	3.3	3.2	23
24	4.4	4.2	4.1	3.9	3.8	3.7	3.6	3.5	3.4	3.3	3.2	3.1	24
25	4.2	4.1	3.9	3.8	3.7	3.5	3.4	3.3	3.2	3.1	3.1	3.0	25
26	4.0	3.9	3.8	3.6	3.5	3.4	3.3	3.2	3.1	3.0	3.0	2.9	26
27	3.9	3.7	3.6	3.5	3.4	3.3	3.2	3.1	3.0	2.9	2.9	2.8	27
28	3.7	3.6	3.5	3.4	3.3	3.2	3.1	3.0	2.9	2.8	2.8	2.7	28
29	3.5	3.4	3.3	3.2	3.1	3.1	3.0	2.9	2.8	2.8	2.7	2.6	29
30	3.4	3.3	3.2	3.1	3.0	3.0	2.9	2.8	2.7	2.7	2.6	2.5	30
31	3.3	3.2	3.1	3.0	2.9	2.9	2.8	2.7	2.6	2.6	2.5	2.5	31
32	3.2	3.1	3.0	2.9	2.8	2.8	2.7	2.6	2.6	2.5	2.5	2.4	32
33	3.0	2.9	2.9	2.8	2.7	2.7	2.6	2.5	2.5	2.4	2.4	2.3	33
34	2.9	2.8	2.8	2.7	2.6	2.6	2.5	2.5	2.4	2.4	2.3	2.3	34
35	2.8	2.7	2.7	2.6	2.5	2.5	2.4	2.4	2.3	2.3	2.2	2.2	35
36	2.7	2.6	2.6	2.5	2.5	2.4	2.4	2.3	2.3	2.2	2.2	2.1	36
37	2.6	2.5	2.5	2.4	2.4	2.3	2.3	2.2	2.2	2.2	2.1	2.1	37
38	2.5	2.5	2.4	2.4	2.3	2.3	2.2	2.2	2.1	2.1	2.1	2.0	38
39	2.4	2.4	2.3	2.3	2.2	2.2	2.1	2.1	2.1	2.0	2.0	2.0	39
40	2.3	2.3	2.2	2.2	2.2	2.1	2.1	2.0	2.0	2.0	1.9	1.9	40
41	2.3	2.2	2.2	2.1	2.1	2.1	2.0	2.0	1.9	1.9	1.9	1.8	41
42	2.2	2.1	2.1	2.1	2.0	2.0	2.0	1.9	1.9	1.9	1.8	1.8	42
43	2.1	2.1	2.0	2.0	2.0	1.9	1.9	1.9	1.8	1.8	1.8	1.7	43
44	2.0	2.0	2.0	1.9	1.9	1.9	1.8	1.8	1.8	1.7	1.7	1.7	44
45	2.0	1.9	1.9	1.9	1.8	1.8	1.8	1.7	1.7	1.7	1.7	1.6	45
46	1.9	1.9	1.8	1.8	1.8	1.7	1.7	1.7	1.7	1.6	1.6	1.6	46
47	1.8	1.8	1.8	1.7	1.7	1.7	1.7	1.6	1.6	1.6	1.6	1.6	47
48	1.8	1.7	1.7	1.7	1.7	1.6	1.6	1.6	1.6	1.6	1.5	1.5	48
49	1.7	1.7	1.7	1.6	1.6	1.6	1.6	1.5	1.5	1.5	1.5	1.5	49
50	1.6	1.6	1.6	1.6	1.6	1.5	1.5	1.5	1.5	1.5	1.4	1.4	50
51	1.6	1.6	1.6	1.5	1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.4	51
52	1.5	1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.4	1.4	1.3	52
53	1.5	1.5	1.4	1.4	1.4	1.4	1.4	1.4	1.3	1.3	1.3	1.3	53
54	1.4	1.4	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.3	1.3	54
55	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	55
56	1.3	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	56
57	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	57
58	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	58
59	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	59
60	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.0	1.0	1.0	1.0	60
	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	
	Declination of a different name from the latitude; upper transit; reduction additive.												

TABLE 26.

Variation of Altitude in one minute from meridian passage.

Latitude.	Declination of a different name from the latitude; upper transit; reduction additive.													Latitude.
	12°	13°	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	24°	
°	″	″	″	″	″	″	″	″	″	″	″	″	″	°
0	9.2	8.5	7.9	7.3	6.8	6.4	6.0	5.7	5.4	5.1	4.9	4.6	4.4	0
1	8.5	7.9	7.4	6.9	6.5	6.1	5.7	5.4	5.1	4.9	4.7	4.4	4.2	1
2	7.9	7.4	6.9	6.5	6.1	5.8	5.5	5.2	4.9	4.7	4.5	4.3	4.1	2
3	7.4	6.9	6.5	6.1	5.8	5.5	5.2	4.9	4.7	4.5	4.3	4.1	3.9	3
4	7.0	6.5	6.2	5.8	5.5	5.2	5.0	4.7	4.5	4.3	4.1	4.0	3.8	4
5	6.5	6.2	5.8	5.5	5.2	5.0	4.8	4.5	4.3	4.2	4.0	3.8	3.7	5
6	6.2	5.8	5.5	5.3	5.0	4.8	4.6	4.4	4.2	4.0	3.9	3.7	3.6	6
7	5.9	5.6	5.3	5.0	4.8	4.6	4.4	4.2	4.0	3.9	3.7	3.6	3.5	7
8	5.6	5.3	5.0	4.8	4.6	4.4	4.2	4.0	3.9	3.7	3.6	3.5	3.4	8
9	5.3	5.0	4.8	4.6	4.4	4.2	4.1	3.9	3.8	3.6	3.5	3.4	3.3	9
10	5.0	4.8	4.6	4.4	4.2	4.1	3.9	3.8	3.6	3.5	3.4	3.3	3.2	10
11	4.8	4.6	4.4	4.2	4.1	3.9	3.8	3.6	3.5	3.4	3.3	3.2	3.1	11
12	4.6	4.4	4.3	4.1	3.9	3.8	3.7	3.5	3.4	3.3	3.2	3.1	3.0	12
13	4.4	4.3	4.1	3.9	3.8	3.7	3.5	3.4	3.3	3.2	3.1	3.0	2.9	13
14	4.2	4.1	3.9	3.8	3.7	3.5	3.4	3.3	3.2	3.1	3.0	2.9	2.8	14
15	4.1	3.9	3.8	3.7	3.5	3.4	3.3	3.2	3.1	3.0	2.9	2.8	2.8	15
16	3.9	3.8	3.7	3.5	3.4	3.3	3.2	3.1	3.0	2.9	2.8	2.8	2.7	16
17	3.8	3.7	3.5	3.4	3.3	3.2	3.1	3.0	2.9	2.8	2.8	2.7	2.6	17
18	3.7	3.5	3.4	3.3	3.2	3.1	3.0	2.9	2.9	2.8	2.7	2.6	2.5	18
19	3.5	3.4	3.3	3.2	3.1	3.0	2.9	2.9	2.8	2.7	2.6	2.6	2.5	19
20	3.4	3.3	3.2	3.1	3.0	2.9	2.9	2.8	2.7	2.6	2.6	2.5	2.4	20
21	3.3	3.2	3.1	3.0	2.9	2.8	2.8	2.7	2.6	2.6	2.5	2.4	2.4	21
22	3.2	3.1	3.0	2.9	2.8	2.8	2.7	2.6	2.6	2.5	2.4	2.4	2.3	22
23	3.1	3.0	2.9	2.8	2.8	2.7	2.6	2.6	2.5	2.4	2.4	2.3	2.3	23
24	3.0	2.9	2.8	2.8	2.7	2.6	2.5	2.5	2.4	2.4	2.3	2.3	2.2	24
25	2.9	2.8	2.7	2.7	2.6	2.5	2.5	2.4	2.4	2.3	2.3	2.2	2.2	25
26	2.8	2.7	2.7	2.6	2.5	2.5	2.4	2.4	2.3	2.3	2.2	2.1	2.1	26
27	2.7	2.7	2.6	2.5	2.5	2.4	2.4	2.3	2.2	2.2	2.1	2.1	2.1	27
28	2.6	2.6	2.5	2.5	2.4	2.3	2.3	2.2	2.2	2.1	2.1	2.1	2.0	28
29	2.6	2.5	2.4	2.4	2.3	2.3	2.2	2.2	2.1	2.1	2.0	2.0	2.0	29
30	2.5	2.4	2.4	2.3	2.3	2.2	2.2	2.1	2.1	2.0	2.0	2.0	1.9	30
31	2.4	2.4	2.3	2.3	2.2	2.2	2.1	2.1	2.0	2.0	2.0	1.9	1.9	31
32	2.3	2.3	2.2	2.2	2.2	2.1	2.1	2.0	2.0	1.9	1.9	1.9	1.8	32
33	2.3	2.2	2.2	2.1	2.1	2.1	2.0	2.0	1.9	1.9	1.9	1.8	1.8	33
34	2.2	2.2	2.1	2.1	2.0	2.0	2.0	1.9	1.9	1.9	1.8	1.8	1.8	34
35	2.2	2.1	2.1	2.0	2.0	2.0	1.9	1.9	1.8	1.8	1.8	1.7	1.7	35
36	2.1	2.1	2.0	2.0	1.9	1.9	1.9	1.8	1.8	1.8	1.7	1.7	1.7	36
37	2.0	2.0	2.0	1.9	1.9	1.9	1.8	1.8	1.8	1.7	1.7	1.7	1.6	37
38	2.0	1.9	1.9	1.9	1.8	1.8	1.8	1.8	1.7	1.7	1.7	1.6	1.6	38
39	1.9	1.9	1.9	1.8	1.8	1.8	1.7	1.7	1.7	1.6	1.6	1.6	1.6	39
40	1.9	1.8	1.8	1.8	1.7	1.7	1.7	1.7	1.6	1.6	1.6	1.6	1.5	40
41	1.8	1.8	1.8	1.7	1.7	1.7	1.6	1.6	1.6	1.6	1.5	1.5	1.5	41
42	1.8	1.7	1.7	1.7	1.7	1.6	1.6	1.6	1.6	1.5	1.5	1.5	1.5	42
43	1.7	1.7	1.7	1.6	1.6	1.6	1.6	1.5	1.5	1.5	1.5	1.4	1.4	43
44	1.7	1.6	1.6	1.6	1.6	1.5	1.5	1.5	1.5	1.5	1.4	1.4	1.4	44
45	1.6	1.6	1.6	1.5	1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.4	45
46	1.6	1.6	1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.4	1.3	1.3	46
47	1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.4	1.3	1.3	1.3	1.3	47
48	1.5	1.5	1.4	1.4	1.4	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.3	48
49	1.4	1.4	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.3	1.2	1.2	49
50	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	50
51	1.4	1.3	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	51
52	1.3	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.1	1.1	52
53	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	53
54	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	54
55	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	55
56	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.0	1.0	1.0	56
57	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.0	57
58	1.1	1.1	1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	58
59	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.9	59
60	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.9	60
	12°	13°	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	24°	
	Declination of a different name from the latitude; upper transit; reduction additive.													

TABLE 26.

Variation of Altitude in one minute from meridian passage.

Latitude.	Declination of a different name from the latitude; upper transit; reduction additive.													Latitude.
	25°	26°	27°	28°	29°	30°	31°	32°	33°	34°	35°	36°	37°	
°	"	"	"	"	"	"	"	"	"	"	"	"	"	°
0	4.2	4.0	3.9	3.7	3.5	3.4	3.3	3.1	3.0	2.9	2.8	2.7	2.6	0
1	4.1	3.9	3.7	3.6	3.4	3.3	3.2	3.1	2.9	2.8	2.7	2.6	2.6	1
2	3.9	3.8	3.6	3.5	3.3	3.2	3.1	3.0	2.9	2.8	2.7	2.6	2.5	2
3	3.8	3.6	3.5	3.4	3.2	3.1	3.0	2.9	2.8	2.7	2.6	2.5	2.4	3
4	3.7	3.5	3.4	3.3	3.2	3.0	2.9	2.8	2.7	2.6	2.6	2.5	2.4	4
5	3.6	3.4	3.3	3.2	3.1	3.0	2.9	2.8	2.7	2.6	2.5	2.4	2.3	5
6	3.4	3.3	3.2	3.1	3.0	2.9	2.8	2.7	2.6	2.5	2.4	2.4	2.3	6
7	3.3	3.2	3.1	3.0	2.9	2.8	2.7	2.6	2.5	2.5	2.4	2.3	2.2	7
8	3.2	3.1	3.0	2.9	2.8	2.7	2.7	2.6	2.5	2.4	2.3	2.3	2.2	8
9	3.1	3.0	2.9	2.9	2.8	2.7	2.6	2.5	2.4	2.4	2.3	2.2	2.2	9
10	3.1	3.0	2.9	2.8	2.7	2.6	2.5	2.5	2.4	2.3	2.2	2.2	2.1	10
11	3.0	2.9	2.8	2.7	2.6	2.5	2.5	2.4	2.3	2.3	2.2	2.1	2.1	11
12	2.9	2.8	2.7	2.6	2.6	2.5	2.4	2.3	2.3	2.2	2.2	2.1	2.0	12
13	2.8	2.7	2.7	2.6	2.5	2.4	2.4	2.3	2.2	2.2	2.1	2.1	2.0	13
14	2.7	2.7	2.6	2.5	2.4	2.4	2.3	2.3	2.2	2.1	2.1	2.0	2.0	14
15	2.7	2.6	2.5	2.5	2.4	2.3	2.3	2.2	2.1	2.1	2.0	2.0	1.9	15
16	2.6	2.5	2.5	2.4	2.3	2.3	2.2	2.2	2.1	2.0	2.0	1.9	1.9	16
17	2.5	2.5	2.4	2.3	2.3	2.2	2.2	2.1	2.1	2.0	2.0	1.9	1.9	17
18	2.5	2.4	2.4	2.3	2.2	2.2	2.1	2.1	2.0	2.0	1.9	1.9	1.8	18
19	2.4	2.4	2.3	2.2	2.2	2.1	2.1	2.0	2.0	1.9	1.9	1.8	1.8	19
20	2.4	2.3	2.3	2.2	2.1	2.1	2.0	2.0	1.9	1.9	1.9	1.8	1.8	20
21	2.3	2.3	2.2	2.1	2.1	2.0	2.0	2.0	1.9	1.9	1.8	1.8	1.7	21
22	2.3	2.2	2.2	2.1	2.1	2.0	2.0	1.9	1.9	1.8	1.8	1.7	1.7	22
23	2.2	2.2	2.1	2.1	2.0	2.0	1.9	1.9	1.8	1.8	1.8	1.7	1.7	23
24	2.2	2.1	2.1	2.0	2.0	1.9	1.9	1.8	1.8	1.8	1.7	1.7	1.6	24
25	2.1	2.1	2.0	2.0	1.9	1.9	1.8	1.8	1.8	1.7	1.7	1.6	1.6	25
26	2.1	2.0	2.0	1.9	1.9	1.9	1.8	1.8	1.7	1.7	1.7	1.6	1.6	26
27	2.0	2.0	1.9	1.9	1.9	1.8	1.8	1.7	1.7	1.7	1.6	1.6	1.6	27
28	2.0	1.9	1.9	1.9	1.8	1.8	1.7	1.7	1.7	1.6	1.6	1.6	1.5	28
29	1.9	1.9	1.9	1.8	1.8	1.7	1.7	1.7	1.6	1.6	1.6	1.5	1.5	29
30	1.9	1.8	1.8	1.8	1.7	1.7	1.7	1.6	1.6	1.6	1.5	1.5	1.5	30
31	1.8	1.8	1.8	1.7	1.7	1.7	1.6	1.6	1.6	1.5	1.5	1.5	1.5	31
32	1.8	1.8	1.7	1.7	1.7	1.6	1.6	1.6	1.5	1.5	1.5	1.5	1.4	32
33	1.8	1.7	1.7	1.7	1.6	1.6	1.6	1.5	1.5	1.5	1.5	1.4	1.4	33
34	1.7	1.7	1.7	1.6	1.6	1.6	1.5	1.5	1.5	1.5	1.4	1.4	1.4	34
35	1.7	1.7	1.6	1.6	1.6	1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.4	35
36	1.6	1.6	1.6	1.6	1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.3	36
37	1.6	1.6	1.6	1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.3	1.3	37
38	1.6	1.5	1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.3	1.3	1.3	38
39	1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.4	1.3	1.3	1.3	1.3	39
40	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.2	40
41	1.5	1.4	1.4	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.2	1.2	41
42	1.4	1.4	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	42
43	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	43
44	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	44
45	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	45
46	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	46
47	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	47
48	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1		48
49	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1			49
50	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1				50
51	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.0					51
52	1.1	1.1	1.1	1.1	1.1	1.1	1.0	1.0						52
53	1.1	1.1	1.1	1.1	1.0	1.0	1.0							53
54	1.1	1.0	1.0	1.0	1.0	1.0								54
55	1.0	1.0	1.0	1.0	1.0									55
56	1.0	1.0	1.0	1.0										56
57	1.0	1.0	1.0											57
58	1.0	0.9												58
59	0.9												0.8	59
60												0.8	0.8	60
	25°	26°	27°	28°	29°	30°	31°	32°	33°	34°	35°	36°	37°	
	Declination of the same name as the latitude; lower transit; reduction subtractive.													

TABLE 26.

Variation of Altitude in one minute from meridian passage.

Declination of a different name from the latitude; upper transit; reduction additive.

Latitude.	38°	39°	40°	41°	42°	43°	44°	45°	46°	47°	48°	49°	50°	Latitude.
°	″	″	″	″	″	″		″	″	″	″	″	″	°
0	2.5	2.4	2.3	2.3	2.2	2.1	[illegible]	2.0	1.9	1.8	1.8	1.7	1.7	0
1	2.5	2.4	2.3	2.2	2.1	2.1	[illegible]	1.9	1.9	1.8	1.7	1.7	1.6	1
2	2.4	2.3	2.3	2.2	2.1	2.0	[illegible]	1.9	1.8	1.8	1.7	1.7	1.6	2
3	2.4	2.3	2.2	2.1	2.1	2.0	[illegible]	1.9	1.8	1.8	1.7	1.6	1.6	3
4	2.3	2.2	2.2	2.1	2.0	2.0	[illegible]	1.8	1.8	1.7	1.7	1.6	1.6	4
5	2.3	2.2	2.1	2.1	2.0	1.9	[illegible]	1.8	1.8	1.7	1.6	1.6	1.5	5
6	2.2	2.2	2.1	2.0	2.0	1.9	[illegible]	1.8	1.7	1.7	1.6	1.6	1.5	6
7	2.2	2.1	2.0	2.0	1.9	1.9	[illegible]	1.8	1.7	1.6	1.6	1.5	1.5	7
8	2.1	2.1	2.0	1.9	1.9	1.8	[illegible]	1.7	1.7	1.6	1.6	1.5	1.5	8
9	2.1	2.0	2.0	1.9	1.9	1.8	[illegible]	1.7	1.6	1.6	1.6	1.5	1.5	9
10	2.1	2.0	1.9	1.9	1.8	1.8	[illegible]	1.7	1.6	1.6	1.5	1.5	1.4	10
11	2.0	2.0	1.9	1.8	1.8	1.7	[illegible]	1.6	1.6	1.6	1.5	1.5	1.4	11
12	2.0	1.9	1.9	1.8	1.8	1.7	[illegible]	1.6	1.6	1.5	1.5	1.4	1.4	12
13	1.9	1.9	1.8	1.8	1.7	1.7	1.6	1.6	1.6	1.5	1.5	1.4	1.4	13
14	1.9	1.9	1.8	1.8	1.7	1.7	1.6	1.6	1.5	1.5	1.4	1.4	1.4	14
15	1.9	1.8	1.8	1.7	1.7	1.6	1.6	1.6	1.5	1.5	1.4	1.4	1.4	15
16	1.8	1.8	1.7	1.7	1.7	1.6	1.6	1.5	1.5	1.4	1.4	1.4	1.3	16
17	1.8	1.8	1.7	1.7	1.6	1.6	1.5	1.5	1.5	1.4	1.4	1.4	1.3	17
18	1.8	1.7	1.7	1.6	1.6	1.6	1.5	1.5	1.4	1.4	1.4	1.3	1.3	18
19	1.7	1.7	1.7	1.6	1.6	1.5	1.5	1.5	1.4	1.4	1.4	1.3	1.3	19
20	1.7	1.7	1.6	1.6	1.6	1.5	1.5	1.4	1.4	1.4	1.3	1.3	1.3	20
21	1.7	1.6	1.6	1.6	1.5	1.5	1.5	1.4	1.4	1.4	1.3	1.3	1.3	21
22	1.7	1.6	1.6	1.5	1.5	1.5	1.4	1.4	1.4	1.3	1.3	1.3	1.2	22
23	1.6	1.6	1.6	1.5	1.5	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.2	23
24	1.6	1.6	1.5	1.5	1.5	1.4	1.4	1.4	1.3	1.3	1.3	1.2	1.2	24
25	1.6	1.5	1.5	1.5	1.4	1.4	1.4	1.3	1.3	1.3	1.2	1.2	1.2	25
26	1.6	1.5	1.5	1.5	1.4	1.4	1.4	1.3	1.3	1.3	1.2	1.2	1.2	26
27	1.5	1.5	1.5	1.4	1.4	1.4	1.3	1.3	1.3	1.2	1.2	1.2	1.2	27
28	1.5	1.5	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.1	28
29	1.5	1.4	1.4	1.4	1.4	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.1	29
30	1.5	1.4	1.4	1.4	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.1	1.1	30
31	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.1	1.1	31
32	1.4	1.4	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.1	1.1	1.1	32
33	1.4	1.4	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	33
34	1.4	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	34
35	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1		35
36	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1			36
37	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1				37
38	1.3	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1					38
39	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1						39
40	1.2	1.2	1.2	1.2	1.1	1.1	1.1							40
41	1.2	1.2	1.2	1.1	1.1	1.1								41
42	1.2	1.2	1.1	1.1	1.1									42
43	1.2	1.1	1.1	1.1										43
44	1.1	1.1	1.1											44
45	1.1	1.1												45
46	1.1												0.9	46
47												0.9	0.9	47
48											0.9	0.9	0.9	48
49										0.9	0.9	0.9	0.8	49
50									0.9	0.9	0.9	0.8	0.8	50
51								0.9	0.9	0.9	0.8	0.8	0.8	51
52							0.9	0.9	0.9	0.8	0.8	0.8	0.8	52
53						0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.8	53
54					0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8	54
55				0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	55
56			0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.7	56
57		0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	57
58	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.7	58
59	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.7	59
60	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	60
	38°	39°	40°	41°	42°	43°	44°	45°	46°	47°	48°	49°	50°	

Declination of the same name as the latitude; lower transit; reduction subtractive.

TABLE 26.

Variation of Altitude in one minute from meridian passage.

Declination of a different name from the latitude; upper transit; reduction additive.

Latitude.	51°	52°	53°	54°	55°	56°	57°	58°	59°	60°	61°	62°	63°	Latitude.
°	″	″	″	″	″	″	″	″	″	″	″	″	″	°
0	1.6	1.5	1.5	1.4	1.4	1.3	1.3	1.2	1.2	1.1	1.1	1.0	1.0	0
1	1.6	1.5	1.5	1.4	1.4	1.3	1.3	1.2	1.2	1.1	1.1	1.0	1.0	1
2	1.5	1.5	1.4	1.4	1.3	1.3	1.3	1.2	1.2	1.1	1.1	1.0	1.0	2
3	1.5	1.5	1.4	1.4	1.3	1.3	1.2	1.2	1.1	1.1	1.1	1.0	1.0	3
4	1.5	1.5	1.4	1.4	1.3	1.3	1.2	1.2	1.1	1.1	1.1	1.0	1.0	4
5	1.5	1.4	1.4	1.3	1.3	1.3	1.2	1.2	1.1	1.1	1.0	1.0	1.0	5
6	1.5	1.4	1.4	1.3	1.3	1.2	1.2	1.2	1.1	1.1	1.0	1.0	1.0	6
7	1.4	1.4	1.4	1.3	1.3	1.2	1.2	1.1	1.1	1.1	1.0	1.0	0.9	7
8	1.4	1.4	1.3	1.3	1.3	1.2	1.2	1.1	1.1	1.1	1.0	1.0	0.9	8
9	1.4	1.4	1.3	1.3	1.2	1.2	1.2	1.1	1.1	1.0	1.0	1.0	0.9	9
10	1.4	1.4	1.3	1.3	1.2	1.2	1.1	1.1	1.1	1.0	1.0	1.0	0.9	10
11	1.4	1.3	1.3	1.3	1.2	1.2	1.1	1.1	1.1	1.0	1.0	1.0	0.9	11
12	1.4	1.3	1.3	1.2	1.2	1.2	1.1	1.1	1.1	1.0	1.0	0.9	0.9	12
13	1.3	1.3	1.3	1.2	1.2	1.2	1.1	1.1	1.0	1.0	1.0	0.9	0.9	13
14	1.3	1.3	1.3	1.2	1.2	1.1	1.1	1.1	1.0	1.0	1.0	0.9	0.9	14
15	1.3	1.3	1.2	1.2	1.2	1.1	1.1	1.1	1.0	1.0	1.0	0.9	0.9	15
16	1.3	1.3	1.2	1.2	1.1	1.1	1.1	1.0	1.0	1.0	0.9	0.9	0.9	16
17	1.3	1.2	1.2	1.2	1.1	1.1	1.1	1.0	1.0	1.0	0.9	0.9	0.9	17
18	1.3	1.2	1.2	1.2	1.1	1.1	1.1	1.0	1.0	1.0	0.9	0.9	0.9	18
19	1.2	1.2	1.2	1.1	1.1	1.1	1.0	1.0	1.0	1.0	0.9	0.9	0.9	19
20	1.2	1.2	1.2	1.1	1.1	1.1	1.0	1.0	1.0	0.9	0.9	0.9	0.8	20
21	1.2	1.2	1.2	1.1	1.1	1.1	1.0	1.0	1.0	0.9	0.9	0.9	0.8	21
22	1.2	1.2	1.1	1.1	1.1	1.0	1.0	1.0	1.0	0.9	0.9	0.9		22
23	1.2	1.2	1.1	1.1	1.1	1.0	1.0	1.0	0.9	0.9	0.9			23
24	1.2	1.1	1.1	1.1	1.1	1.0	1.0	1.0	0.9	0.9				24
25	1.2	1.1	1.1	1.1	1.0	1.0	1.0	1.0	0.9					25
26	1.1	1.1	1.1	1.1	1.0	1.0	1.0	0.9						26
27	1.1	1.1	1.1	1.0	1.0	1.0	1.0							27
28	1.1	1.1	1.1	1.0	1.0	1.0								28
29	1.1	1.1	1.0	1.0	1.0									29
30	1.1	1.1	1.0	1.0										30
31	1.1	1.0	1.0											31
32	1.1	1.0												32
33	1.1												0.8	33
34												0.8	0.7	34
35											0.8	0.8	0.7	35
36										0.8	0.8	0.8	0.7	36
37									0.8	0.8	0.8	0.7	0.7	37
38								0.8	0.8	0.8	0.8	0.7	0.7	38
39							0.8	0.8	0.8	0.8	0.8	0.7	0.7	39
40						0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.7	40
41					0.9	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	41
42				0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	42
43			0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.7	43
44		0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.7	44
45	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.7	45
46	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.7	46
47	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.6	47
48	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.6	48
49	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	49
50	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	50
51	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	51
52	0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	52
53	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.6	53
54	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.6	54
55	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.6	55
56	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	56
57	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	57
58	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	58
59	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.5	59
60	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.5	60
	51°	52°	53°	54°	55°	56°	57°	58°	59°	60°	61°	62°	63°	

Declination of the same name as the latitude; lower transit; reduction subtractive.

TABLE 27.

Reduction to be applied to Altitudes near the Meridian.

Var. 1 min. (Table 26.)	Time from meridian passage.													Var. 1 min. (Table 26.)
	m. s. 0 30	m. s. 1 0	m. s. 1 30	m. s. 2 0	m. s. 2 30	m. s. 3 0	m. s. 3 30	m. s. 4 0	m. s. 4 30	m. s. 5 0	m. s. 5 30	m. s. 6 0	m. s. 6 30	
″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	″
0.1	0 0	0 0	0 0	0 0	0 1	0 1	0 1	0 2	0 2	0 2	0 3	0 4	0 4	0.1
0.2	0 0	0 0	0 0	0 1	0 1	0 2	0 3	0 3	0 4	0 5	0 6	0 7	0 8	0.2
0.3	0 0	0 0	0 1	0 1	0 2	0 3	0 4	0 5	0 6	0 7	0 9	0 11	0 13	0.3
0.4	0 0	0 0	0 1	0 2	0 2	0 4	0 5	0 6	0 8	0 10	0 12	0 14	0 17	0.4
0.5	0 0	0 0	0 1	0 2	0 3	0 4	0 6	0 8	0 10	0 12	0 15	0 18	0 21	0.5
0.6	0 0	0 1	0 1	0 2	0 4	0 5	0 7	0 10	0 12	0 15	0 18	0 22	0 25	0.6
0.7	0 0	0 1	0 2	0 3	0 4	0 6	0 9	0 11	0 14	0 17	0 21	0 25	0 30	0.7
0.8	0 0	0 1	0 2	0 3	0 5	0 7	0 10	0 13	0 16	0 20	0 24	0 29	0 34	0.8
0.9	0 0	0 1	0 2	0 4	0 6	0 8	0 11	0 14	0 18	0 22	0 27	0 32	0 38	0.9
1.0	0 0	0 1	0 2	0 4	0 6	0 9	0 12	0 16	0 20	0 25	0 30	0 36	0 42	1.0
2.0	0 0	0 2	0 4	0 8	0 12	0 18	0 24	0 32	0 41	0 50	1 0	1 12	1 24	2.0
3.0	0 1	0 3	0 7	0 12	0 19	0 27	0 37	0 48	1 1	1 15	1 31	1 48	2 6	3.0
4.0	0 1	0 4	0 9	0 16	0 25	0 36	0 49	1 4	1 21	1 40	2 1	2 24	2 49	4.0
5.0	0 1	0 5	0 11	0 20	0 31	0 45	1 1	1 20	1 41	2 5	2 31	3 0	3 31	5.0
6.0	0 1	0 6	0 13	0 24	0 37	0 54	1 13	1 36	2 1	2 30	3 1	3 36	4 13	6.0
7.0	0 2	0 7	0 16	0 28	0 44	1 3	1 26	1 52	2 22	2 55	3 32	4 12	4 56	7.0
8.0	0 2	0 8	0 18	0 32	0 50	1 12	1 38	2 8	2 42	3 20	4 2	4 48	5 38	8.0
9.0	0 2	0 9	0 20	0 36	0 56	1 21	1 50	2 24	3 2	3 45	4 32	5 24	6 20	9.0
10.0	0 2	0 10	0 22	0 40	1 2	1 30	2 3	2 40	3 23	4 10	5 2	6 0	7 2	10.0
11.0	0 3	0 11	0 25	0 44	1 9	1 39	2 15	2 56	3 43	4 35	5 32	6 36	7 45	11.0
12.0	0 3	0 12	0 27	0 48	1 15	1 48	2 27	3 12	4 3	5 0	6 3	7 12	8 27	12.0
13.0	0 3	0 13	0 29	0 52	1 21	1 57	2 39	3 28	4 23	5 25	6 33	7 48	9 9	13.0
14.0	0 3	0 14	0 31	0 56	1 27	2 6	2 51	3 44	4 43	5 50	7 4	8 24	9 51	14.0
15.0	0 4	0 15	0 34	1 0	1 34	2 15	3 4	4 0	5 3	6 15	7 34	9 0	10 34	15.0
16.0	0 4	0 16	0 36	1 4	1 40	2 24	3 16	4 16	5 24	6 40	8 4	9 36	11 16	16.0
17.0	0 4	0 17	0 38	1 8	1 46	2 33	3 28	4 32	5 44	7 5	8 34	10 12	11 58	17.0
18.0	0 4	0 18	0 40	1 12	1 52	2 42	3 40	4 48	6 4	7 30	9 4	10 48	12 40	18.0
19.0	0 5	0 19	0 43	1 16	1 59	2 51	3 53	5 4	6 25	7 55	9 35	11 24	13 23	19.0
20.0	0 5	0 20	0 45	1 20	2 5	3 0	4 5	5 20	6 45	8 20	10 5	12 0	14 5	20.0
21.0	0 5	0 21	0 47	1 24	2 11	3 9	4 17	5 36	7 5	8 45	10 35	12 36	14 47	21.0
22.0	0 5	0 22	0 49	1 28	2 17	3 18	4 30	5 52	7 25	9 10	11 5	13 12	15 29	22.0
23.0	0 6	0 23	0 52	1 32	2 24	3 27	4 42	6 8	7 46	9 35	11 36	13 48	16 12	23.0
24.0	0 6	0 24	0 54	1 36	2 30	3 36	4 54	6 24	8 6	10 0	12 6	14 24	16 54	24.0
25.0	0 6	0 25	0 56	1 40	2 36	3 45	5 6	6 40	8 26	10 25	12 36	15 0		25.0
26.0	0 6	0 26	0 58	1 44	2 42	3 54	5 18	6 56	8 46	10 50	13 6			26.0
27.0	0 7	0 27	1 1	1 48	2 49	4 3	5 30	7 12	9 7	11 15				27.0
28.0	0 7	0 28	1 8	1 52	2 55	4 12	5 43	7 28	9 27	11 40				28.0

TABLE 27.

Reduction to be applied to Altitudes near the Meridian.

Var. 1 min. (Table 26.)	Time from meridian passage.													Var. 1 min. (Table 26.)
	m. s. 7 0	m. s. 7 30	m. s. 8 0	m. s. 8 30	m. s. 9 0	m. s. 9 30	m. s. 10 0	m. s. 10 30	m. s. 11 0	m. s. 11 30	m. s. 12 0	m. s. 12 30	m. s. 13 0	
″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	″
0.1	0 5	0 6	0 6	0 7	0 8	0 9	0 10	0 11	0 12	0 13	0 14	0 16	0 17	0.1
0.2	0 10	0 11	0 13	0 14	0 16	0 18	0 20	0 22	0 24	0 26	0 29	0 31	0 34	0.2
0.3	0 15	0 17	0 19	0 22	0 24	0 27	0 30	0 33	0 36	0 40	0 43	0 47	0 51	0.3
0.4	0 20	0 23	0 26	0 29	0 32	0 36	0 40	0 44	0 48	0 53	0 58	1 2	1 8	0.4
0.5	0 24	0 28	0 32	0 36	0 40	0 45	0 50	0 55	1 0	1 6	1 12	1 18	1 24	0.5
0.6	0 29	0 34	0 38	0 43	0 49	0 54	1 0	1 6	1 13	1 19	1 26	1 34	1 41	0.6
0.7	0 34	0 39	0 45	0 51	0 57	1 3	1 10	1 17	1 25	1 33	1 41	1 49	1 58	0.7
0.8	0 39	0 45	0 51	0 58	1 5	1 12	1 20	1 28	1 37	1 46	1 55	2 5	2 15	0.8
0.9	0 44	0 51	0 57	1 5	1 13	1 21	1 30	1 39	1 49	1 59	2 10	2 21	2 32	0.9
1.0	0 49	0 56	1 4	1 12	1 21	1 30	1 40	1 50	2 1	2 12	2 24	2 36	2 49	1.0
2.0	1 38	1 52	2 8	2 24	2 42	3 0	3 20	3 40	4 2	4 24	4 48	5 12	5 38	2.0
3.0	2 27	2 49	3 12	3 37	4 3	4 30	5 0	5 31	6 3	6 37	7 12	7 49	8 27	3.0
4.0	3 16	3 45	4 16	4 49	5 24	6 1	6 40	7 21	8 4	8 49	9 36	10 25	11 16	4.0
5.0	4 5	4 41	5 20	6 1	6 45	7 31	8 20	9 11	10 5	11 1	12 0	13 1	14 5	5.0
6.0	4 54	5 37	6 24	7 14	8 6	9 1	10 0	11 1	12 6	13 13	14 24	15 37	16 54	6.0
7.0	5 43	6 34	7 28	8 26	9 27	10 32	11 40	12 52	14 7	15 26	16 48	18 14	19 43	7.0
8.0	6 32	7 30	8 32	9 38	10 48	12 2	13 20	14 42	16 8	17 38	19 12	20 50	22 32	8.0
9.0	7 21	8 26	9 36	10 50	12 9	13 32	15 0	16 32	18 9	19 50	21 36	23 26	25 21	9.0
10.0	8 10	9 22	10 40	12 2	13 30	15 2	16 40	18 22	20 10	22 2	24 0	26 2	28 10	10.0
11.0	8 59	10 19	11 44	13 15	14 51	16 33	18 20	20 13	22 11	24 15	26 24	28 39		11.0
12.0	9 48	11 15	12 48	14 27	16 12	18 3	20 0	22 3	24 12	26 27	28 48			12.0
13.0	10 37	12 11	13 52	15 39	17 33	19 33	21 40	23 53	26 13	28 39				13.0
14.0	11 26	13 7	14 56	16 51	18 54	21 3	23 20	25 43	28 14					14.0
15.0	12 15	14 4	16 0	18 14	20 15	22 34	25 0	27 34						15.0
16.0	13 4	15 0	17 4	19 16	21 36	24 4	26 40							16.0
17.0	13 53	15 56	18 8	20 28	22 57	25 34								17.0
18.0	14 42	16 52	19 12	21 40	24 18									18.0
19.0	15 31	17 49	20 16											19.0
20.0	16 20	18 45												20.0
21.0	17 9													21.0

TABLE 27.

Reduction to be applied to Altitudes near the Meridian

Var. 1 min. (Table 26.)	Time from meridian passage.													Var. 1 min. (Table 26.)
	m. s. 13 30	m. s. 14 0	m. s. 14 30	m. s. 15 0	m. s. 15 30	m. s. 16 0	m. s. 16 30	m. s. 17 0	m. s. 17 30	m. s. 18 0	m. s. 18 30	m. s. 19 0	m. s. 19 30	
″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	″
0.1	0 18	0 20	0 21	0 22	0 24	0 26	0 27	0 29	0 31	0 32	0 34	0 36	0 38	0.1
0.2	0 36	0 39	0 42	0 45	0 48	0 51	0 54	0 58	1 1	1 5	1 8	1 12	1 16	0.2
0.3	0 55	0 59	1 3	1 7	1 12	1 17	1 22	1 27	1 32	1 37	1 43	1 48	1 54	0.3
0.4	1 13	1 18	1 24	1 30	1 36	1 42	1 49	1 56	2 2	2 10	2 17	2 24	2 32	0.4
0.5	1 31	1 38	1 45	1 52	2 0	2 8	2 16	2 24	2 33	2 42	2 51	3 1	3 10	0.5
0.6	1 49	1 58	2 6	2 15	2 24	2 34	2 43	2 53	3 4	3 14	3 25	3 37	3 48	0.6
0.7	2 8	2 17	2 27	2 37	2 48	2 59	3 11	3 22	3 34	3 47	4 0	4 13	4 26	0.7
0.8	2 26	2 37	2 48	3 0	3 12	3 25	3 38	3 51	4 5	4 19	4 34	4 49	5 4	0.8
0.9	2 44	2 56	3 9	3 22	3 36	3 50	4 5	4 20	4 36	4 52	5 8	5 25	5 42	0.9
1.0	3 2	3 16	3 30	3 45	4 0	4 16	4 32	4 49	5 6	5 24	5 42	6 1	6 20	1.0
2.0	6 4	6 32	7 0	7 30	8 0	8 32	9 4	9 38	10 12	10 48	11 24	12 2	12 40	2.0
3.0	9 7	9 48	10 30	11 15	12 1	12 48	13 38	14 27	15 19	16 12	17 7	18 3	19 1	3.0
4.0	12 9	13 14	14 1	15 0	16 1	17 4	18 9	19 16	20 25	21 36	22 49	24 4	25 21	4.0
5.0	15 11	16 20	17 31	18 45	20 1	21 20	22 41	24 5	25 31	27 0	28 31			5.0
6.0	18 13	19 36	21 2	22 30	24 1	25 36	27 13							6.0
7.0	21 16	22 52	24 32	26 15	28 1									7.0
8.0	24 18	26 8	28 2											8.0
9.0	27 20													9.0

Var. 1 min. (Table 26.)	Time from meridian passage.													Var. 1 min. (Table 26.)
	m. s. 20 0	m. s. 20 30	m. s. 21 0	m. s. 21 30	m. s. 22 0	m. s. 22 30	m. s. 23 0	m. s. 23 30	m. s. 24 0	m. s. 24 30	m. s. 25 0	m. s. 25 30	m. s. 26 0	
″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	″
0.1	0 40	0 42	0 44	0 46	0 48	0 51	0 53	0 55	0 58	1 0	1 2	1 6	1 8	0.1
0.2	1 20	1 24	1 28	1 32	1 37	1 41	1 46	1 50	1 55	2 0	2 5	2 10	2 15	0.2
0.3	2 0	2 6	2 12	2 19	2 25	2 32	2 39	2 46	2 53	3 0	3 7	3 15	3 23	0.3
0.4	2 40	2 48	2 56	3 5	3 14	3 22	3 32	3 41	3 50	4 0	4 10	4 20	4 30	0.4
0.5	3 20	3 30	3 41	3 51	4 2	4 13	4 24	4 36	4 48	5 0	5 12	5 25	5 38	0.5
0.6	4 0	4 12	4 25	4 37	4 50	5 4	5 17	5 31	5 46	6 0	6 15	6 30	6 46	0.6
0.7	4 40	4 54	5 9	5 24	5 39	5 54	6 10	6 27	6 43	7 0	7 17	7 35	7 53	0.7
0.8	5 20	5 36	5 53	6 10	6 27	6 45	7 3	7 22	7 41	8 0	8 20	8 40	9 1	0.8
0.9	6 0	6 18	6 37	6 56	7 16	7 36	7 56	8 17	8 38	9 0	9 22	9 45	10 8	0.9
1.0	6 40	7 0	7 21	7 42	8 4	8 26	8 49	9 12	9 36	10 0	10 25	10 50	11 16	1.0
2.0	13 20	14 0	14 42	15 24	16 8	16 52	17 38	18 24	19 12	20 0	20 50	21 40	22 32	2.0
3.0	20 0	21 0	22 3	23 7	24 12	25 19	26 27	27 37	28 48	30 0				3.0
4.0	26 40	28 1	29 24											4.0

Note.—The pages formerly occupied with Tables 28A, 28B, 28C, and 28D have been dropped, and consecutive page numbering is thereby broken.

TABLE 29.

Conversion Tables for Nautical and Statute Miles.

Nautical miles into statute miles.

1 nautical mile or knot = 6,080.20 feet.
1 statute mile = 5,280 feet.

Nautical miles.	Statute miles.	Nautical miles.	Statute miles.
1	1.15	51	58.729
2	2.30	52	59.881
3	3.45	53	61.032
4	4.61	54	62.184
5	5.76	55	63.335
6	6.91	56	64.487
7	8.06	57	65.639
8	9.21	58	66.790
9	10.36	59	67.942
10	11.52	60	69.093
11	12.667	61	70.245
12	13.819	62	71.396
13	14.970	63	72.548
14	16.122	64	73.699
15	17.273	65	74.851
16	18.425	66	76.003
17	19.576	67	77.154
18	20.728	68	78.306
19	21.880	69	79.457
20	23.031	70	80.609
21	24.183	71	81.760
22	25.334	72	82.912
23	26.486	73	84.063
24	27.637	74	85.215
25	28.789	75	86.366
26	29.940	76	87.518
27	31.092	77	88.670
28	32.243	78	89.821
29	33.395	79	90.973
30	34.547	80	92.124
31	35.698	81	93.276
32	36.850	82	94.427
33	38.001	83	95.579
34	39.153	84	96.730
35	40.304	85	97.882
36	41.456	86	99.034
37	42.607	87	100.185
38	43.759	88	101.337
39	44.911	89	102.488
40	46.062	90	103.640
41	47.214	91	104.791
42	48.365	92	105.942
43	49.517	93	107.094
44	50.668	94	108.246
45	51.820	95	109.397
46	52.971	96	110.549
47	54.123	97	111.701
48	55.275	98	112.852
49	56.426	99	114.004
50	57.578	100	115.155

Statute miles into nautical miles.

1 statute mile = 5,280 feet
1 nautical mile or knot = 6,080.20 feet.

Statute miles.	Nautical miles.	Statute miles.	Nautical miles.
1	0.87	51	44.288
2	1.74	52	45.156
3	2.61	53	46.025
4	3.47	54	46.893
5	4.34	55	47.762
6	5.21	56	48.630
7	6.08	57	49.498
8	6.95	58	50.367
9	7.82	59	51.235
10	8.68	60	52.104
11	9.552	61	52.972
12	10.421	62	53.840
13	11.289	63	54.709
14	12.158	64	55.577
15	13.026	65	56.445
16	13.894	66	57.314
17	14.763	67	58.182
18	15.631	68	59.051
19	16.499	69	59.919
20	17.368	70	60.787
21	18.236	71	61.656
22	19.105	72	62.524
23	19.973	73	63.393
24	20.841	74	64.261
25	21.710	75	65.129
26	22.578	76	65.998
27	23.447	77	66.866
28	24.315	78	67.735
29	25.183	79	68.603
30	26.052	80	69.471
31	26.920	81	70.340
32	27.789	82	71.208
33	28.657	83	72.077
34	29.525	84	72.945
35	30.394	85	73.813
36	31.262	86	74.682
37	32.131	87	75.550
38	32.999	88	76.419
39	33.867	89	77.287
40	34.736	90	78.155
41	35.604	91	79.024
42	36.473	92	79.892
43	37.341	93	80.760
44	38.209	94	81.629
45	39.078	95	82.497
46	39.946	96	83.366
47	40.814	97	84.234
48	41.683	98	85.102
49	42.551	99	85.971
50	43.420	100	86.839

TABLE 30.

Conversion Tables for Metric and English Linear Measure.

Metric to English.

Meters.	Feet.	Yards.	Statute miles.	Nautical miles.
1	3.280 833 3	1.093 611 1	0.000 621 369	0.000 539 593
2	6.561 666 7	2.187 222 2	.001 242 738	.001 079 185
3	9.842 500 0	3.280 833 3	.001 864 106	.001 618 778
4	13.123 333 3	4.374 444 4	.002 485 475	.002 158 370
5	16.404 166 7	5.468 055 6	.003 106 844	.002 697 963
6	19.685 000 0	6.561 666 7	.003 728 213	.003 237 556
7	22.965 833 3	7.655 277 8	.004 349 582	.003 777 148
8	26.246 666 7	8.748 888 9	.004 970 950	.004 316 741
9	29.527 500 0	9.842 500 0	.005 592 319	.004 856 333

English to metric.

No.	Feet to meters.	Yards to meters.	Statute miles to meters.	Nautical miles to meters.
1	0.304 800 6	0.914 401 8	1,609.35	1,853.25
2	0.609 601 2	1.828 803 7	3,218.70	3,706.50
3	0.914 401 8	2.743 205 5	4,828.05	5,559.75
4	1.219 202 4	3.657 607 3	6,437.40	7,413.00
5	1.524 003 0	4.572 009 1	8,046.75	9,266.25
6	1.828 803 7	5.486 411 0	9,656.10	11,119.50
7	2.133 604 3	6.400 812 8	11,265.45	12,972.75
8	2.438 404 9	7.315 214 6	12,874.80	14,826.00
9	2.743 205 5	8.229 616 5	14,484.15	16,679.25

TABLE 31.

Conversion Tables for Thermometer Scales.

[F°=Fahrenheit temperature; C°=Centigrade temperature; R°=Réaumur temperature.]

Equivalent temperatures—Fahr., Cent., Réau

$$R° = \tfrac{4}{5}\,C° = \tfrac{4}{9}\,(F° - 32°).$$
$$C° = \tfrac{5}{4}\,R° = \tfrac{5}{9}\,(F° - 32°).$$

F°.	C°.	R°.	F°.	C°.	R°.
1	—17.2	—13.8	51	+10.6	+ 8.4
2	16.7	13.3	52	11.1	8.9
3	16.1	12.9	53	11.7	9.3
4	15.6	12.4	54	12.2	9.8
5	15.0	12.0	55	12.8	10.2
6	14.4	11.6	56	13.3	10.7
7	13.9	11.1	57	13.9	11.1
8	13.3	10.7	58	14.4	11.6
9	12.8	10.2	59	15.0	12.0
10	12.2	9.8	60	15.6	12.4
11	11.7	9.3	61	16.1	12.9
12	11.1	8.9	62	16.7	13.3
13	10.6	8.4	63	17.2	13.8
14	10.0	8.0	64	17.8	14.2
15	9.4	7.6	65	18.3	14.7
16	8.9	7.1	66	18.9	15.1
17	8.3	6.7	67	19.4	15.6
18	7.8	6.2	68	20.0	16.0
19	7.2	5.8	69	20.6	16.4
20	6.7	5.3	70	21.1	16.9
21	6.1	4.9	71	21.7	17.3
22	5.6	4.4	72	22.2	17.8
23	5.0	4.0	73	22.8	18.2
24	4.4	3.6	74	23.3	18.7
25	3.9	3.1	75	23.9	19.1
26	3.3	2.7	76	24.4	19.6
27	2.8	2.2	77	25.0	20.0
28	2.2	1.8	78	25.6	20.4
29	1.7	1.3	79	26.1	20.9
30	1.1	0.9	80	26.7	21.3
31	— 0.6	— 0.4	81	27.2	21.8
32	0.0	0.0	82	27.8	22.2
33	+ 0.6	+ 0.4	83	28.3	22.7
34	1.1	0.9	84	28.9	23.1
35	1.7	1.3	85	29.4	23.6
36	2.2	1.8	86	30.0	24.0
37	2.8	2.2	87	30.6	24.4
38	3.3	2.7	88	31.1	24.9
39	3.9	3.1	89	31.7	25.3
40	4.4	3.6	90	32.2	25.8
41	5.0	4.0	91	32.8	26.2
42	5.6	4.4	92	33.3	26.7
43	6.1	4.9	93	33.9	27.1
44	6.7	5.3	94	34.4	27.6
45	7.2	5.8	95	35.0	28.0
46	7.8	6.2	96	35.6	28.4
47	8.3	6.7	97	36.1	28.9
48	8.9	7.1	98	36.7	29.3
49	9.4	7.6	99	37.2	29.8
50	+10.0	+ 8.0	100	+37.8	+30.2

Equivalent temperatures—Centigrade and Fahrenheit.

$$F° = \tfrac{9}{5}\,C° + 32°.$$

C°.	F°.	C°.	F°.	C°.	F°.	C°.	F°.	C°.	F°.
—10	14.0	0	32.0	10	50.0	20	68.0	30	86.0
— 9	15.8	1	33.8	11	51.8	21	69.8	31	87.8
— 8	17.6	2	35.6	12	53.6	22	71.6	32	89.6
— 7	19.4	3	37.4	13	55.4	23	73.4	33	91.4
— 6	21.2	4	39.2	14	57.2	24	75.2	34	93.2
— 5	23.0	5	41.0	15	59.0	25	77.0	35	95.0
— 4	24.8	6	42.8	16	60.8	26	78.8	36	96.8
— 3	26.6	7	44.6	17	62.6	27	80.6	37	98.6
— 2	28.4	8	46.4	18	64.4	28	82.4	38	100.4
— 1	30.2	9	48.2	19	66.2	29	84.2	39	102.2

Equivalent temperatures—Réaumur and Fahrenheit.

$$F° = \tfrac{9}{4}\,R° + 32°.$$

R°.	F°.	R°.	F°.	R°.	F°.	R°.	F°.
—10	9.5	0	32.0	10	54.5	20	77.0
— 9	11.8	1	34.2	11	56.8	21	79.2
— 8	14.0	2	36.5	12	59.0	22	81.5
— 7	16.2	3	38.8	13	61.2	23	83.8
— 6	18.5	4	41.0	14	63.5	24	86.0
— 5	20.8	5	43.2	15	65.8	25	88.2
— 4	23.0	6	45.5	16	68.0	26	90.5
— 3	25.2	7	47.8	17	70.2	27	92.8
— 2	27.5	8	50.0	18	72.5	28	95.0
— 1	29.8	9	52.2	19	74.8	29	97.2

TABLE 32.

To obtain the True Force and Direction of the Wind from its Apparent Force and Direction on a Moving Vessel.

Apparent force of the wind (Beaufort scale).	Speed of vessel, knots.	Apparent direction of the wind (points off the bow).																																	
		0		1		2		3		4		5		6		7		8		9		10		11		12		13		14		15		16	
		True direction, points off the bow.	True force, Beaufort scale.	True direction, points off the bow.	True force, Beaufort scale.	True direction, points off the bow.	True force, Beaufort scale.	True direction, points off the bow.	True force, Beaufort scale.	True direction, points off the bow.	True force, Beaufort scale.	True direction, points off the bow.	True force, Beaufort scale.	True direction, points off the bow.	True force, Beaufort scale.	True direction, points off the bow.	True force, Beaufort scale.	True direction, points off the bow.	True force, Beaufort scale.	True direction, points off the bow.	True force, Beaufort scale.	True direction, points off the bow.	True force, Beaufort scale.	True direction, points off the bow.	True force, Beaufort scale.	True direction, points off the bow.	True force, Beaufort scale.	True direction, points off the bow.	True force, Beaufort scale.	True direction, points off the bow.	True force, Beaufort scale.	True direction, points off the bow.	True force, Beaufort scale.	True direction, points off the bow.	True force, Beaufort scale.
0	10	16	1	16	1	15	1	15	1	15	1	15	1	15	2	15	2	15	2	15	2	15	2	15	2	15	2	15	2	15	2	16	2	16	2
	15	16	2	16	2	16	2	15	2	15	2	15	2	15	3	15	3	15	3	15	3	15	3	15	3	15	3	16	3	16	3	16	3	16	3
	20	16	3	16	3	16	3	16	4	15	4	15	4	15	4	15	4	15	4	15	4	15	4	15	4	16	4	16	5	16	5	16	5	16	5
1	10	16	0	14	0	13	0	12	1	12	1	12	1	12	2	13	2	13	2	13	2	14	3	14	3	14	3	15	3	15	3	16	3	16	3
	15	16	1	15	1	14	2	14	2	14	2	14	2	14	3	14	3	14	3	14	3	14	4	14	4	15	4	15	4	15	4	16	4	16	4
	20	16	2	15	2	15	3	15	3	14	3	14	3	14	4	14	4	14	4	14	4	15	5	15	5	15	5	15	5	15	5	16	5	16	5
2	10	0	0	6	0	7	0	8	1	9	1	10	2	10	2	11	3	12	3	12	3	13	3	13	4	14	4	14	4	15	4	15	4	16	4
	15	16	0	13	0	12	1	12	1	12	2	12	2	12	3	12	3	13	4	13	4	13	4	14	5	14	5	15	5	15	5	16	5	16	5
	20	16	1	15	2	14	2	13	2	13	3	13	3	13	4	13	4	13	5	14	5	14	5	14	6	15	6	15	6	15	6	16	6	16	6
3	10	0	1	8	1	5	1	6	2	8	2	8	2	9	3	10	3	11	4	12	4	12	4	13	5	14	5	14	5	15	5	15	5	16	5
	15	0	0	8	0	8	1	9	1	10	2	10	3	11	3	11	4	12	4	12	5	13	5	13	6	14	6	14	6	15	6	15	6	16	6
	20	16	0	13	1	12	1	12	2	12	3	12	3	12	4	12	5	13	5	13	6	13	6	14	6	14	7	15	7	15	7	16	7	16	7
4	10	0	2	2	2	4	2	6	2	7	3	8	3	9	4	10	4	10	4	11	5	12	5	13	5	13	6	14	6	15	6	15	6	16	6
	15	0	1	4	1	6	1	7	2	8	3	9	3	10	4	11	5	11	5	12	6	12	6	13	6	14	7	14	7	15	7	15	7	16	7
	20	.....	0	9	0	9	1	10	2	10	3	10	4	11	4	12	5	12	5	12	6	13	7	14	7	14	7	14	8	15	8	16	8	16	8
5	10	0	3	2	3	3	3	5	3	6	4	7	4	8	5	9	5	10	5	11	6	12	6	12	6	13	7	14	7	15	7	15	7	16	7
	15	0	2	3	2	5	2	6	3	7	3	8	4	9	5	10	5	11	6	12	6	12	7	13	7	14	7	14	7	15	8	15	8	16	8
	20	0	0	5	1	7	2	8	3	9	3	10	3	10	5	11	6	12	6	12	7	13	7	13	8	14	8	14	8	15	8	15	8	16	8
6	10	0	4	2	4	3	4	4	4	6	5	7	5	8	6	9	6	10	6	11	7	11	7	12	7	13	7	14	7	14	8	15	8	16	8
	15	0	3	2	3	4	3	5	4	7	4	8	5	9	6	10	6	10	7	11	7	12	7	13	8	13	8	14	8	15	8	15	8	16	8
	20	0	2	3	2	5	2	7	3	8	4	9	5	10	6	10	7	11	7	12	7	12	8	13	8	14	8	14	9	14	9	15	9	16	9
7	10	0	5	1	5	3	5	4	6	5	6	6	6	7	7	8	7	9	7	10	7	11	8	12	8	13	8	14	8	14	8	15	8	16	8
	15	0	4	2	4	3	4	5	5	6	5	7	6	8	6	9	7	10	7	11	8	12	8	12	8	13	9	14	9	15	9	15	9	16	9
	20	0	3	2	3	4	4	6	4	7	5	8	6	9	7	10	7	11	8	11	8	12	9	13	9	13	9	14	9	15	10	15	10	16	10
8	10	0	6	1	6	3	7	4	7	5	7	6	7	7	8	8	8	9	8	10	8	11	9	12	9	13	9	14	9	14	9	15	9	16	9
	15	0	5	2	6	3	6	4	6	6	7	7	7	8	8	9	8	10	8	11	9	11	9	12	9	13	10	14	10	15	10	15	10	16	10
	20	0	4	2	5	4	5	5	6	6	6	8	7	9	8	9	8	10	9	11	9	12	10	13	10	13	10	14	10	15	10	15	11	16	11
9	10	0	8	1	8	2	8	4	8	5	8	6	8	7	9	8	9	9	9	10	9	11	10	12	10	13	10	13	10	14	10	15	10	16	10
	15	0	7	1	7	3	7	4	7	5	8	6	8	8	8	9	9	10	9	10	10	11	10	12	10	13	10	14	11	14	11	15	11	16	11
	20	0	6	2	6	3	6	5	7	6	7	7	8	8	8	9	8	10	9	11	10	12	10	12	10	13	11	14	11	15	11	15	11	16	11
10	10	0	9	1	9	2	9	4	9	5	9	6	9	7	10	8	10	9	10	10	10	11	11	12	11	13	11	13	11	14	11	15	11	16	11
	15	0	8	1	8	3	8	4	8	5	9	6	9	7	9	8	10	9	10	10	11	11	11	12	11	13	11	14	11	14	11	15	11	16	11
	20	0	7	2	7	3	8	4	8	6	8	7	9	8	9	9	10	10	10	11	11	11	11	12	11	13	12	14	12	15	12	16	12	16	12
11	10	0	10	1	10	2	10	4	10	5	10	6	10	7	11	8	11	9	11	10	11	11	11	12	11	12	12	13	12	14	12	15	12	16	12
	15	0	9	1	9	3	9	4	10	5	10	6	10	7	11	8	11	9	11	10	11	11	12	12	12	13	12	14	12	14	12	15	12	16	12
	20	0	9	1	9	3	9	4	9	5	10	7	10	8	10	9	11	10	11	10	12	11	12	12	12	13	12	14	12	14	12	15	12	16	12
12	10	0	11	1	11	2	11	3	11	4	11	6	12	7	12	8	12	9	12	10	12	11	12	12	12	12	12	13	12	14	12	15	12	16	12
	15	0	11	1	11	2	11	4	11	5	11	6	11	7	12	8	12	9	12	10	12	11	12	12	12	13	12	13	12	14	12	15	12	16	12
	20	0	10	1	10	3	10	4	11	5	11	6	11	7	12	8	12	9	12	10	12	11	12	12	12	13	12	14	12	14	12	15	12	16	12

TABLE 33.

Distance by Vertical Angle.

Dist., knots.	Heights in feet.																	
	40	45	50	55	60	65	70	75	80	85	90	95	100	110	120	130	140	150.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
0.1	3 46	4 14	4 42	5 10	5 38	6 06	6 34	7 02	7 30	7 58	8 25	8 53	9 20	10 15	11 10	12 04	12 58	13 52
.2	1 53	2 07	2 21	2 35	2 49	3 04	3 18	3 32	3 46	4 00	4 14	4 28	4 42	5 10	5 38	6 06	6 34	7 02
.3	1 15	1 25	1 34	1 44	1 53	2 02	2 12	2 21	2 31	2 40	2 49	2 59	3 08	3 27	3 46	4 05	4 23	4 42
.4	0 57	1 04	1 11	1 18	1 25	1 32	1 39	1 46	1 53	2 00	2 07	2 14	2 21	2 35	2 49	3 04	3 18	3 32
0.5	0 45	0 51	0 57	1 02	1 08	1 14	1 19	1 25	1 30	1 36	1 42	1 47	1 53	2 04	2 16	2 27	2 38	2 49
.6	0 38	0 42	0 47	0 52	0 57	1 01	1 06	1 11	1 15	1 20	1 25	1 30	1 34	1 44	1 53	2 02	2 12	2 21
.7	0 32	0 36	0 40	0 44	0 48	0 53	0 57	1 01	1 05	1 09	1 13	1 17	1 21	1 29	1 37	1 45	1 53	2 01
.8	0 28	0 32	0 35	0 39	0 42	0 46	0 49	0 53	0 57	1 00	1 04	1 07	1 11	1 18	1 25	1 32	1 39	1 46
.9	0 25	0 28	0 31	0 35	0 38	0 41	0 44	0 47	0 50	0 53	0 57	1 00	1 03	1 09	1 15	1 22	1 28	1 34
1.0	0 23	0 25	0 28	0 31	0 34	0 37	0 40	0 42	0 45	0 48	0 51	0 54	0 57	1 02	1 08	1 14	1 19	1 25
.1	0 21	0 23	0 26	0 28	0 31	0 33	0 36	0 39	0 41	0 44	0 46	0 49	0 51	0 57	1 02	1 07	1 12	1 17
.2	0 19	0 21	0 24	0 26	0 28	0 31	0 33	0 35	0 38	0 40	0 42	0 45	0 47	0 52	0 57	1 01	1 06	1 11
.3	0 17	0 20	0 22	0 24	0 26	0 28	0 30	0 33	0 35	0 37	0 39	0 41	0 44	0 48	0 52	0 57	1 01	1 05
.4	0 16	0 18	0 20	0 22	0 24	0 26	0 28	0 30	0 32	0 34	0 36	0 38	0 40	0 44	0 48	0 53	0 57	1 01
1.5	0 15	0 17	0 19	0 21	0 23	0 25	0 26	0 28	0 30	0 32	0 34	0 36	0 38	0 41	0 45	0 49	0 53	0 57
.6	0 14	0 16	0 18	0 19	0 21	0 23	0 25	0 27	0 28	0 30	0 32	0 34	0 35	0 39	0 42	0 46	0 49	0 53
.7	0 13	0 15	0 17	0 18	0 20	0 22	0 23	0 25	0 27	0 28	0 30	0 32	0 33	0 37	0 40	0 43	0 47	0 50
.8	0 13	0 14	0 16	0 17	0 19	0 20	0 22	0 24	0 25	0 27	0 28	0 30	0 31	0 35	0 38	0 41	0 44	0 47
.9	0 12	0 13	0 15	0 16	0 18	0 19	0 21	0 22	0 24	0 25	0 27	0 28	0 30	0 33	0 36	0 39	0 42	0 45
2.0	0 11	0 13	0 14	0 16	0 17	0 18	0 20	0 21	0 23	0 24	0 25	0 27	0 28	0 31	0 34	0 37	0 40	0 42
.1	0 11	0 13	0 14	0 15	0 16	0 18	0 19	0 20	0 22	0 23	0 24	0 26	0 27	0 30	0 32	0 35	0 38	0 40
.2	0 10	0 12	0 13	0 14	0 15	0 17	0 18	0 19	0 21	0 22	0 23	0 24	0 26	0 28	0 31	0 33	0 36	0 39
.3	0 10	0 12	0 12	0 14	0 14	0 16	0 17	0 18	0 20	0 21	0 22	0 23	0 25	0 27	0 30	0 32	0 34	0 37
.4	0 10	0 11	0 12	0 13	0 14	0 15	0 17	0 18	0 19	0 20	0 21	0 22	0 24	0 26	0 28	0 31	0 33	0 35
2.5	0 9	0 11	0 11	0 12	0 13	0 15	0 16	0 17	0 18	0 19	0 20	0 21	0 23	0 25	0 27	0 29	0 32	0 34
.6	0 9	0 10	0 11	0 12	0 13	0 14	0 15	0 16	0 17	0 18	0 20	0 21	0 22	0 24	0 26	0 28	0 30	0 33
.7	0 9	0 10	0 10	0 11	0 12	0 14	0 15	0 16	0 17	0 18	0 19	0 20	0 21	0 23	0 25	0 27	0 29	0 31
.8	0 8	0 9	0 10	0 11	0 12	0 13	0 14	0 15	0 16	0 17	0 18	0 19	0 20	0 22	0 24	0 26	0 28	0 30
.9	0 8	0 9	0 10	0 10	0 11	0 13	0 14	0 15	0 16	0 17	0 18	0 19	0 20	0 21	0 23	0 25	0 27	0 29
3.0	0 8	0 9	0 9	0 10	0 10	0 12	0 13	0 14	0 15	0 16	0 17	0 18	0 19	0 21	0 23	0 25	0 26	0 28
.2							0 12	0 13	0 14	0 15	0 16	0 17	0 18	0 19	0 21	0 23	0 25	0 27
.4							0 12	0 12	0 13	0 14	0 15	0 16	0 17	0 18	0 20	0 22	0 23	0 25
.6							0 11	0 12	0 13	0 13	0 14	0 15	0 16	0 17	0 19	0 20	0 22	0 24
.8							0 10	0 11	0 12	0 13	0 13	0 14	0 15	0 16	0 18	0 19	0 21	0 22
4.0							0 10	0 11	0 11	0 12	0 13	0 13	0 14	0 16	0 17	0 18	0 20	0 21
.2										0 11	0 12	0 13	0 14	0 15	0 16	0 17	0 19	0 20
.4										0 11	0 12	0 12	0 13	0 14	0 15	0 17	0 18	0 19
.6										0 10	0 11	0 12	0 13	0 14	0 15	0 16	0 17	0 18
.8										0 10	0 11	0 11	0 12	0 13	0 14	0 15	0 16	0 18
5.0										0 10	0 10	0 11	0 11	0 12	0 14	0 15	0 16	0 17

TABLE 33.

Distance by Vertical Angle.

Dist., knots.	Heights in feet.																	
	160	170	180	190	200	300	400	500	600	700	800	900	1,000	1,200	1,400	1,600	1,800	2,000
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
0.1	14 45	15 37	16 29	17 21	18 13	26 16												
.2	7 30	7 58	8 25	8 53	9 20	13 52	18 13	22 21	26 16	29 56								
.3	5 01	5 19	5 38	5 57	6 15	9 20	12 22	15 20	18 13	21 00	23 41	26 16	28 44					
.4	3 46	4 00	4 14	4 28	4 42	7 02	9 20	11 37	13 52	16 03	18 13	20 18	22 21	26 16	29 56			
0.5	3 01	3 12	3 23	3 35	3 46	5 38	7 30	9 20	11 10	12 58	14 45	16 30	18 13	21 32	24 44	27 46	30 38	
.6	2 31	2 40	2 49	2 59	3 08	4 42	6 15	7 48	9 20	10 52	12 22	13 52	15 20	18 13	21 00	23 41	26 16	28 44
.7	2 09	2 17	2 25	2 33	2 41	4 02	5 22	6 42	8 01	9 20	10 39	11 56	13 13	15 45	18 13	20 36	22 56	25 10
.8	1 53	2 00	2 07	2 14	2 21	3 32	4 42	5 52	7 02	8 11	9 20	10 29	11 37	13 52	16 03	18 13	20 18	22 21
.9	1 40	1 47	1 53	1 59	2 06	3 08	4 11	5 13	6 15	7 17	8 19	9 20	10 21	12 22	14 21	16 18	18 13	20 05
1.0	1 30	1 36	1 42	1 47	1 53	2 49	3 46	4 42	5 38	6 34	7 30	8 25	9 20	11 10	12 58	14 45	16 29	18 13
.1	1 22	1 27	1 33	1 38	1 43	2 34	3 25	4 17	5 08	5 59	6 49	7 40	8 30	10 10	11 49	13 27	15 04	16 39
.2	1 15	1 20	1 25	1 30	1 34	2 21	3 08	3 55	4 42	5 29	6 15	7 02	7 48	9 20	10 52	12 22	13 52	15 20
.3	1 10	1 14	1 18	1 23	1 27	2 10	2 54	3 37	4 20	5 04	5 47	6 30	7 13	8 38	10 03	11 27	12 50	14 12
.4	1 05	1 09	1 13	1 17	1 21	2 01	2 41	3 22	4 02	4 42	5 22	6 02	6 42	8 01	9 20	10 39	11 56	13 13
1.5	1 00	1 04	1 08	1 12	1 15	1 53	2 31	3 08	3 46	4 23	5 01	5 38	6 15	7 30	8 44	9 57	11 10	12 22
.6	0 57	1 00	1 04	1 07	1 11	1 46	2 21	2 57	3 32	4 07	4 42	5 17	5 52	7 02	8 11	9 20	10 29	11 37
.7	0 53	0 57	1 00	1 03	1 07	1 40	2 13	2 46	3 19	3 52	4 26	4 59	5 32	6 38	7 43	8 48	9 53	10 57
.8	0 50	0 53	0 57	1 00	1 03	1 34	2 06	2 37	3 08	3 40	4 11	4 42	5 13	6 15	7 17	8 19	9 20	10 21
.9	0 48	0 51	0 54	0 57	1 00	1 29	1 59	2 29	2 58	3 28	3 58	4 27	4 57	5 56	6 55	7 54	8 52	9 50
2.0	0 45	0 48	0 51	0 54	0 57	1 25	1 53	2 21	2 49	3 18	3 46	4 14	4 42	5 38	6 34	7 30	8 25	9 20
.1	0 43	0 46	0 48	0 51	0 54	1 21	1 48	2 15	2 41	3 08	3 35	4 02	4 29	5 22	6 15	7 08	8 01	8 53
.2	0 41	0 44	0 46	0 49	0 51	1 17	1 43	2 08	2 34	3 00	3 25	3 51	4 17	5 08	5 59	6 49	7 40	8 30
.3	0 39	0 42	0 44	0 47	0 49	1 14	1 38	2 03	2 27	2 52	3 16	3 41	4 05	4 55	5 44	6 32	7 21	8 09
.4	0 38	0 40	0 42	0 45	0 47	1 11	1 34	1 58	2 21	2 45	3 08	3 32	3 55	4 42	5 29	6 15	7 02	7 48
2.5	0 36	0 38	0 41	0 43	0 45	1 08	1 30	1 53	2 16	2 38	3 01	3 23	3 46	4 31	5 16	6 01	6 45	7 30
.6	0 35	0 37	0 39	0 41	0 44	1 05	1 27	1 49	2 10	2 32	2 54	3 16	3 37	4 20	5 04	5 47	6 30	7 13
.7	0 34	0 36	0 38	0 40	0 42	1 03	1 24	1 45	2 06	2 27	2 47	3 08	3 29	4 11	4 53	5 34	6 15	6 57
.8	0 32	0 34	0 36	0 38	0 40	1 01	1 21	1 41	2 01	2 21	2 41	3 02	3 22	4 02	4 42	5 22	6 02	6 42
.9	0 31	0 33	0 35	0 37	0 39	0 58	1 18	1 37	1 57	2 16	2 36	2 55	3 15	3 54	4 32	5 11	5 50	6 28
3.0	0 30	0 32	0 34	0 36	0 38	0 57	1 15	1 34	1 53	2 12	2 31	2 49	3 08	3 46	4 23	5 01	5 38	6 15
.2	0 28	0 30	0 32	0 34	0 35	0 53	1 11	1 28	1 46	2 04	2 21	2 39	2 57	3 32	4 07	4 42	5 17	5 52
.4	0 27	0 28	0 30	0 32	0 33	0 50	1 07	1 23	1 40	1 56	2 13	2 30	2 46	3 19	3 52	4 26	4 59	5 32
.6	0 25	0 27	0 28	0 30	0 31	0 47	1 03	1 19	1 34	1 50	2 06	2 21	2 37	3 08	3 40	4 11	4 42	5 13
.8	0 24	0 25	0 27	0 28	0 30	0 45	1 00	1 14	1 29	1 44	1 59	2 14	2 29	2 58	3 28	3 58	4 27	4 57
4.0	0 23	0 24	0 25	0 27	0 28	0 42	0 57	1 11	1 25	1 39	1 53	2 07	2 21	2 49	3 18	3 46	4 14	4 42
.2	0 22	0 23	0 24	0 26	0 27	0 40	0 54	1 07	1 21	1 34	1 48	2 01	2 15	2 41	3 08	3 35	4 02	4 29
.4	0 21	0 22	0 23	0 24	0 26	0 39	0 51	1 04	1 17	1 30	1 43	1 56	2 08	2 34	3 00	3 25	3 51	4 17
.6	0 20	0 21	0 22	0 23	0 25	0 37	0 49	1 01	1 14	1 26	1 38	1 51	2 03	2 27	2 52	3 16	3 41	4 05
.8	0 19	0 20	0 21	0 22	0 24	0 35	0 47	0 59	1 11	1 22	1 34	1 46	1 58	2 21	2 45	3 08	3 32	3 55
5.0	0 18	0 19	0 20	0 21	0 23	0 34	0 45	0 57	1 08	1 19	1 30	1 42	1 53	2 16	2 38	3 01	3 23	3 46

TABLE 34.

For finding the distance of an object by an angle, measured from an elevated position, between the object and the horizon beyond.

Dist., yards.	Height of the Eye Above the Level of the Sea, in Feet.											Dist., yards.
	20	30	40	50	60	70	80	90	100	110	120	
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	
100	3 44	5 37	7 29	9 21	11 11	13 00	14 47	16 34	18 16	19 58	21 37	100
200	1 50	2 46	3 43	4 39	5 35	6 31	7 27	8 23	9 18	10 13	11 08	200
300	1 12	1 49	2 26	3 04	3 41	4 19	4 56	5 33	6 11	6 48	7 25	300
400	52	1 21	1 48	2 16	2 44	3 12	3 40	4 08	4 36	5 04	5 32	400
500	41	1 03	1 25	1 48	2 10	2 32	2 54	3 17	3 39	4 01	4 24	500
600	34	52	1 10	1 29	1 47	2 05	2 24	2 42	3 01	3 20	3 38	600
700	28	44	1 01	1 15	1 31	1 46	2 01	2 18	2 34	2 50	3 05	700
800	24	38	51	1 05	1 18	1 32	1 46	2 00	2 13	2 27	2 41	800
900	21	33	45	57	1 09	1 22	1 33	1 45	1 57	2 10	2 22	900
1,000	18	29	40	50	1 01	1 12	1 23	1 34	1 45	1 56	2 07	1,000
1,100	16	26	35	45	55	1 05	1 15	1 24	1 34	1 44	1 54	1,100
1,200	15	23	32	41	50	59	1 08	1 17	1 26	1 35	1 44	1,200
1,300	13	21	29	37	45	53	1 02	1 10	1 18	1 27	1 35	1,300
1,400	12	19	27	34	41	49	57	1 04	1 12	1 20	1 27	1,400
1,500	11	18	24	31	38	45	52	59	1 07	1 14	1 21	1,500
1,600	10	16	22	29	35	42	48	55	1 02	1 08	1 15	1,600
1,700		15	21	27	33	39	45	51	58	1 04	1 10	1,700
1,800		14	19	25	31	36	42	48	54	1 00	1 06	1,800
1,900		13	18	23	29	34	39	45	50	56	1 02	1,900
2,000		12	17	22	27	32	37	42	47	53	58	2,000
2,100		11	16	20	25	30	35	40	45	50	55	2,100
2,200		10	15	19	24	28	33	38	42	47	52	2,200
2,300			14	18	22	27	31	36	40	45	49	2,300
2,400			13	17	21	25	29	34	38	42	47	2,400
2,500			12	16	20	24	28	32	36	40	44	2,500
2,600			11	15	19	23	26	30	34	38	42	2,600
2,700			11	14	18	22	25	29	33	36	40	2,700
2,800			10	14	17	20	24	28	31	35	38	2,800
2,900				13	16	19	23	26	30	33	37	2,900
3,000				12	15	19	22	25	28	32	35	3,000
3,100				12	15	18	21	24	27	30	34	3,100
3,200				11	14	17	20	23	26	29	32	3,200
3,300				10	13	16	19	22	25	28	31	3,300
3,400					13	15	18	21	24	27	30	3,400
3,500					12	15	17	20	23	26	29	3,500
3,600					12	14	17	19	22	25	27	3,600
3,700					11	13	16	19	21	24	26	3,700
3,800					11	13	15	18	20	23	25	3,800
3,900					10	12	15	17	20	22	25	3,900
4,000						12	14	16	19	21	24	4,000
4,100						11	14	16	18	20	23	4,100
4,200						11	13	15	17	20	22	4,200
4,300						10	13	15	17	19	21	4,300
4,400							12	14	16	18	21	4,400
4,500							12	14	16	18	20	4,500
4,600							11	13	15	17	19	4,600
4,700							11	13	15	17	19	4,700
4,800							10	12	14	16	18	4,800
4,900								12	14	15	17	4,900
5,000								11	13	15	17	5,000

TABLE 35.

Speed in knots per hour developed by a vessel traversing a measured nautical mile in any given number of minutes and seconds.

Sec.	Number of minutes.												Sec.
	1	2	3	4	5	6	7	8	9	10	11	12	
	Knots.	*Knots.*	*Knots.*	*Knots.*	*Knots.*	*Knots.*	*Knots.*	*Knots.*	*Knots.*	*Knots.*	*Knots.*	*Knots.*	
0	60.000	30.000	20.000	15.000	12.000	10.000	8.571	7.500	6.666	6.000	5.455	5.000	0
1	59.016	29.752	19.890	14.938	11.960	9.972	8.551	7.484	6.654	5.990	5.446	4.993	1
2	58.065	29.508	19.780	14.876	11.920	9.944	8.530	7.468	6.642	5.980	5.438	4.986	2
3	57.143	29.268	19.672	14.815	11.880	9.917	8.510	7.453	6.629	5.970	5.429	4.979	3
4	56.250	29.032	19.565	14.754	11.841	9.890	8.490	7.438	6.617	5.960	5.421	4.972	4
5	55.385	28.800	19.460	14.694	11.803	9.863	8.470	7.422	6.605	5.950	5.413	4.965	5
6	54.545	28.571	19.355	14.634	11.764	9.836	8.450	7.407	6.593	5.940	5.405	4.958	6
7	53.731	28.346	19.251	14.575	11.726	9.809	8.430	7.392	6.581	5.930	5.397	4.951	7
8	52.941	28.125	19.149	14.516	11.688	9.783	8.411	7.377	6.569	5.921	5.389	4.945	8
9	52.174	27.907	19.048	14.458	11.650	9.756	8.392	7.362	6.557	5.911	5.381	4.938	9
10	51.429	27.692	18.947	14.400	11.613	9.729	8.372	7.346	6.545	5.902	5.373	4.932	10
11	50.704	27.481	18.848	14.342	11.575	9.703	8.353	7.331	6.533	5.892	5.365	4.924	11
12	50.000	27.273	18.750	14.286	11.538	9.677	8.334	7.317	6.521	5.882	5.357	4.918	12
13	49.315	27.068	18.652	14.229	11.501	9.651	8.315	7.302	6.509	5.872	5.349	4.911	13
14	48.649	26.866	18.556	14.173	11.465	9.625	8.295	7.287	6.498	5.863	5.341	4.904	14
15	48.000	26.667	18.461	14.118	11.428	9.600	8.276	7.272	6.486	5.853	5.333	4.897	15
16	47.368	26.471	18.367	14.063	11.392	9.574	8.257	7.258	6.474	5.844	5.325	4.891	16
17	46.753	26.277	18.274	14.008	11.356	9.549	8.238	7.243	6.463	5.834	5.317	4.884	17
18	46.154	26.087	18.182	13.953	11.321	9.524	8.219	7.229	6.451	5.825	5.309	4.878	18
19	45.570	25.899	18.090	13.900	11.285	9.499	8.200	7.214	6.440	5.815	5.301	4.871	19
20	45.000	25.714	18.000	13.846	11.250	9.473	8.181	7.200	6.428	5.806	5.294	4.865	20
21	44.444	25.532	17.910	13.793	11.214	9.448	8.163	7.185	6.417	5.797	5.286	4.858	21
22	43.902	25.352	17.822	13.740	11.180	9.424	8.144	7.171	6.405	5.787	5.278	4.851	22
23	43.373	25.175	17.734	13.688	11.146	9.399	8.126	7.157	6.394	5.778	5.270	4.845	23
24	42.857	25.000	17.647	13.636	11.111	9.375	8.108	7.142	6.383	5.769	5.263	4.838	24
25	42.353	24.828	17.560	13.584	11.077	9.350	8.090	7.128	6.371	5.760	5.255	4.832	25
26	41.860	24.658	17.475	13.533	11.043	9.326	8.071	7.114	6.360	5.750	5.247	4.825	26
27	41.379	24.490	17.391	13.483	11.009	9.302	8.053	7.100	6.349	5.741	5.240	4.819	27
28	40.909	24.324	17.307	13.433	10.975	9.278	8.035	7.086	6.338	5.732	5.232	4.812	28
29	40.449	24.161	17.225	13.383	10.942	9.254	8.017	7.072	6.327	5.723	5.224	4.806	29
30	40.000	24.000	17.143	13.333	10.909	9.230	8.000	7.059	6.315	5.714	5.217	4.800	30
31	39.560	23.841	17.061	13.284	10.876	9.207	7.982	7.045	6.304	5.705	5.210	4.793	31
32	39.130	23.684	16.981	13.235	10.843	9.183	7.964	7.031	6.293	5.696	5.202	4.787	32
33	38.710	23.529	16.901	13.186	10.810	9.160	7.947	7.017	6.282	5.687	5.195	4.780	33
34	38.298	23.377	16.822	13.138	10.778	9.137	7.929	7.004	6.271	5.678	5.187	4.774	34
35	37.895	23.226	16.744	13.091	10.746	9.113	7.912	6.990	6.260	5.669	5.179	4.768	35
36	37.500	28.077	16.667	13.043	10.714	9.090	7.895	6.977	6.250	5.660	5.172	4.761	36
37	37.113	22.930	16.590	12.996	10.682	9.068	7.877	6.963	6.239	5.651	5.164	4.755	37
38	36.735	22.785	16.514	12.950	10.651	9.045	7.860	6.950	6.228	5.642	5.157	4.749	38
39	36.364	22.642	16.438	12.903	10.619	9.022	7.843	6.936	6.217	5.633	5.150	4.743	39
40	36.000	22.500	16.363	12.857	10.588	9.000	7.826	6.923	6.207	5.625	5.143	4.737	40
41	35.644	22.360	16.289	12.811	10.557	8.977	7.809	6.909	6.196	5.616	5.135	4.731	41
42	35.294	22.222	16.216	12.766	10.526	8.955	7.792	6.896	6.185	5.607	5.128	4.724	42
43	34.951	22.086	16.143	12.721	10.495	8.933	7.775	6.883	6.174	5.598	5.121	4.718	43
44	34.615	21.951	16.071	12.676	10.465	8.911	7.758	6.870	6.164	5.590	5.114	4.712	44
45	34.286	21.818	16.000	12.631	10.434	8.889	7.741	6.857	6.153	5.581	5.106	4.706	45
46	33.962	21.687	15.929	12.587	10.404	8.867	7.725	6.844	6.143	5.572	5.099	4.700	46
47	33.645	21.557	15.859	12.543	10.375	8.845	7.708	6.831	6.132	5.564	5.091	4.693	47
48	33.333	21.429	15.789	12.500	10.345	8.823	7.692	6.818	6.122	5.555	5.084	4.687	48
49	33.028	21.302	15.721	12.456	10.315	8.801	7.675	6.805	6.112	5.547	5.077	4.681	49
50	32.727	21.176	15.652	12.413	10.286	8.780	7.659	6.792	6.101	5.538	5.070	4.675	50
51	32.432	21.053	15.584	12.371	10.256	8.759	7.643	6.779	6.091	5.530	5.063	4.669	51
52	32.143	20.930	15.517	12.329	10.227	8.737	7.627	6.766	6.081	5.521	5.056	4.663	52
53	31.858	20.809	15.450	12.287	10.198	8.716	7.611	6.754	6.071	5.513	5.049	4.657	53
54	31.579	20.690	15.384	12.245	10.169	8.695	7.595	6.741	6.060	5.504	5.042	4.651	54
55	31.304	20.571	15.319	12.203	10.140	8.675	7.579	6.739	6.050	5.496	5.035	4.645	55
56	31.034	20.455	15.254	12.162	10.112	8.654	7.563	6.716	6.040	5.487	5.028	4.639	56
57	30.769	20.339	15.190	12.121	10.084	8.633	7.547	6.704	6.030	5.479	5.020	4.633	57
58	30.508	20.225	15.126	12.080	10.055	8.612	7.531	6.691	6.020	5.471	5.013	4.627	58
59	30.252	20.112	15.062	12.040	10.027	8.591	7.515	6.679	6.010	5.463	5.006	4.621	59
Sec.	1	2	3	4	5	6	7	8	9	10	11	12	Sec.

TABLE 36.

Reduction of Local Mean Time to Standard Meridian Time, and the reverse.

[If local meridian is east of standard meridian, subtract from local mean time, or add to standard meridian time. If local meridian is west of standard meridian, add to local mean time, or subtract from standard meridian time.]

Difference of longitude between local meridian and standard meridian.	Reduction to be applied to local mean time.	Difference of longitude between local meridian and standard meridian.	Reduction to be applied to local mean time.
° ′ ° ′	*Minutes.*	° ′ ° ′	*Minutes.*
0 00 to 0 07	0	7 23 to 7 37	30
0 08 to 0 22	1	7 38 to 7 52	31
0 23 to 0 37	2	7 53 to 8 07	32
0 38 to 0 52	3	8 08 to 8 22	33
0 53 to 1 07	4	8 23 to 8 37	34
1 08 to 1 22	5	8 38 to 8 52	35
1 23 to 1 37	6	8 53 to 9 07	36
1 38 to 1 52	7	9 08 to 9 22	37
1 53 to 2 07	8	9 23 to 9 37	38
2 08 to 2 22	9	9 38 to 9 52	39
2 23 to 2 37	10	9 53 to 10 07	40
2 38 to 2 52	11	10 08 to 10 22	41
2 53 to 3 07	12	10 23 to 10 37	42
3 08 to 3 22	13	10 38 to 10 52	43
3 23 to 3 37	14	10 53 to 11 07	44
3 38 to 3 52	15	11 08 to 11 22	45
3 53 to 4 07	16	11 23 to 11 37	46
4 08 to 4 22	17	11 38 to 11 52	47
4 23 to 4 37	18	11 53 to 12 07	48
4 38 to 4 52	19	12 08 to 12 22	49
4 53 to 5 07	20	12 23 to 12 37	50
5 08 to 5 22	21	12 38 to 12 52	51
5 23 to 5 37	22	12 53 to 13 07	52
5 38 to 5 52	23	13 08 to 13 22	53
5 53 to 6 07	24	13 23 to 13 37	54
6 08 to 6 22	25	13 38 to 13 52	55
6 23 to 6 37	26	13 53 to 14 07	56
6 38 to 6 52	27	14 08 to 14 22	57
6 53 to 7 07	28	14 23 to 14 37	58
7 08 to 7 22	29	14 38 to 14 52	59

Note.—The pages formerly occupied with Tables 37 and 37A have been dropped, and consecutive page numbering is thereby broken.

TABLE 38.

Error in Longitude due to one minute Error of Latitude.

Sun's altitude.	Polar distance.	Latitude.																Polar distance.	Sun's altitude.
		0°	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°		
°	°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°	°
10	110	.4	.4	.4	.5	.5	.6	.7	.8	1.0	1.3	1.8	2.9					110	10
20		.4	.4	.5	.6	.7	.8	1.0	1.2	1.6	2.6								20
30		.4	.5	.6	.7	.9	1.1	1.5	2.3										30
40		.5	.6	.8	1.0	1.3													40
50		.7	.9	1.2															50
60		.9																	60
10	105	.3	.3	.3	.3	.4	.4	.5	.6	.8	.9	1.2	1.8	3.0				105	10
20		.3	.3	.4	.4	.5	.6	.7	.9	1.2	1.6	2.7							20
30		.3	.4	.5	.6	.7	.8	1.1	1.5	2.4									30
40		.4	.5	.6	.7	1.0	1.3												40
50		.4	.6	.8	1.2														50
60		.6	.9																60
15	100	.2	.2	.2	.3	.3	.4	.4	.5	.6	.8	1.1	1.6	2.9				100	15
20		.2	.2	.3	.3	.4	.5	.5	.7	.9	1.1	1.6	2.7						20
30		.2	.3	.3	.4	.5	.6	.8	1.1	1.5	2.4								30
40		.2	.3	.4	.6	.7	.9	1.3	2.1										40
50		.3	.4	.6	.8	1.2													50
60		.3	.6	.9															60
15	95	.1	.1	.1	.2	.2	.3	.3	.4	.5	.6	.8	1.1	1.7	3.0			95	15
20		.1	.1	.2	.2	.3	.3	.4	.5	.6	.8	1.1	1.6	2.8					20
30		.1	.2	.2	.3	.4	.5	.6	.8	1.0	1.5	2.5							30
40		.1	.2	.3	.4	.5	.7	.9	1.3	2.1									40
50		.1	.3	.4	.6	.8	1.1												50
60		.2	.3	.6	.9														60
20	90	.0	.0	.1	.1	.1	.2	.2	.3	.4	.6	.7	1.1	1.6	3.0			90	20
30		.0	.1	.1	.2	.2	.3	.4	.5	.7	1.0	1.5	2.7						30
40		.0	.1	.2	.3	.3	.5	.6	.9	1.3	2.2								40
50		.0	.1	.2	.4	.5	.8	1.1											50
60		.0	.2	.3	.5	.9													60
70		.0	.2	.6	1.1														70
20	85	.1*	.1*	.0	.0	.0	.1	.1	.2	.3	.3	.5	.7	1.0	1.6	3.1		85	20
30		.1*	.0	.0	.1	.1	.2	.2	.4	.5	.7	1.0	1.5	2.7					30
40		.1*	.0	.0	.1	.2	.3	.4	.6	.9	1.3	2.3							40
50		.1*	.0	.1	.2	.3	.5	.7	1.1										50
60		.2*	.0	.1	.3	.5	.9												60
70		.3*	.0	.2	.6	1.1													70
20	80	.2*	.2*	.1*	.1*	.1*	.0	.0	.0	.1	.1	.2	.4	.5	.9	1.5	3.1	80	20
30		.2*	.2*	.1*	.0	.0	.1	.1	.2	.3	.4	.6	.9	1.5	2.8				30
40		.2*	.2*	.1*	.0	.1	.2	.3	.4	.6	.9	1.3	2.4						40
50		.3*	.2*	.1*	.1	.2	.3	.5	.7	1.1									50
60		.4*	.2*	.0	.1	.3	.5	.9											60
70		.6*	.3*	.0	.2	.6	1.2												70
20	75	.3*	.3*	.2*	.2*	.2*	.1*	.1*	.1*	.1*	.0	.0	.1	.2	.3	.6	1.2	75	20
30		.3*	.3*	.2*	.2*	.1*	.1*	.0	.1	.1	.2	.4	.6	.9	1.5	3.0			30
40		.4*	.3*	.2*	.1*	.1*	.0	.1	.2	.4	.5	.8	1.3	2.5					40
50		.4*	.3*	.2*	.1*	.0	.1	.3	.5	.7	1.1								50
60		.6*	.4*	.2*	.1*	.1	.3	.5	.9										60
70		1.2*	.6*	.3*	.0	.2	.6	1.2											70
20	70	.4*	.4*	.3*	.3*	.3*	.3*	.2*	.2*	.2*	.2*	.2*	.2*	.2*	.2*	.2*	.2*	70	20
30		.4*	.4*	.3*	.3*	.2*	.2*	.1*	.1*	.0	.0	.1	.2	.6	.8	1.5	3.1		30
40		.5*	.4*	.3*	.3*	.2*	.1*	.0	.1	.2	.3	.5	.8	1.3	2.6				40
50		.6*	.5*	.3*	.2*	.2*	.0	.1	.3	.4	.7	1.1							50
60		.9*	.6*	.4*	.3*	.1*	.1	.2	.5	.9									60
70			1.2*	.6*	.3*	.1*	.2	.6	1.2										70
Sun's altitude.	Polar distance.	0°	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	Polar distance.	Sun's altitude.
		Latitude.																	

TABLE 39.

Amplitudes.

Latitude.	Declination.													Latitude.
	0°.0	0°.5	1°.0	1°.5	2°.0	2°.5	3°.0	3°.5	4°.0	4°.5	5°.0	5°.5	6°.0	
°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
0	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	0
10	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.1	4.6	5.1	5.6	6.1	10
15	0.0	0.5	1.0	1.5	2.1	2.6	3.1	3.6	4.2	4.7	5.2	5.7	6.2	15
20	0.0	0.5	1.1	1.6	2.1	2.7	3.2	3.7	4.3	4.8	5.3	5.8	6.4	20
25	0.0	0.5	1.1	1.6	2.2	2.8	3.3	3.8	4.4	5.0	5.5	6.0	6.6	25
30	0.0	0.6	1.2	1.7	2.3	2.9	3.4	4.0	4.6	5.2	5.8	6.3	6.9	30
32	0.0	0.6	1.2	1.8	2.4	2.9	3.5	4.1	4.7	5.3	5.9	6.5	7.0	32
34	0.0	0.6	1.2	1.8	2.4	3.0	3.6	4.2	4.8	5.4	6.0	6.6	7.2	34
36	0.0	0.6	1.2	1.8	2.5	3.1	3.7	4.3	4.9	5.6	6.1	6.8	7.4	36
38	0.0	0.6	1.3	1.9	2.5	3.2	3.8	4.4	5.1	5.7	6.3	7.0	7.6	38
40	0.0	0.7	1.3	2.0	2.6	3.3	3.9	4.6	5.2	5.9	6.5	7.2	7.8	40
42	0.0	0.7	1.3	2.0	2.7	3.4	4.0	4.7	5.4	6.1	6.7	7.4	8.0	42
44	0.0	0.7	1.4	2.1	2.8	3.5	4.2	4.9	5.6	6.3	6.9	7.6	8.3	44
46	0.0	0.7	1.4	2.2	2.9	3.6	4.3	5.0	5.8	6.5	7.2	7.9	8.6	46
48	0.0	0.7	1.5	2.2	3.0	3.7	4.5	5.2	6.0	6.7	7.5	8.2	9.0	48
50	0.0	0.8	1.5	2.3	3.1	3.9	4.7	5.4	6.2	7.0	7.8	8.6	9.3	50
51	0.0	0.8	1.6	2.4	3.2	4.0	4.8	5.6	6.4	7.2	8.0	8.8	9.5	51
52	0.0	0.8	1.6	2.4	3.3	4.1	4.9	5.7	6.5	7.3	8.1	9.0	9.7	52
53	0.0	0.8	1.6	2.5	3.3	4.2	5.0	5.8	6.7	7.5	8.3	9.2	10.0	53
54	0.0	0.9	1.7	2.5	3.4	4.3	5.1	6.0	6.8	7.7	8.5	9.4	0.2	54
55	0.0	0.9	1.7	2.6	3.5	4.4	5.2	6.1	7.0	7.9	8.7	9.6	10.5	55
56	0.0	0.9	1.8	2.7	3.6	4.5	5.4	6.3	7.2	8.1	9.0	9.9	0.8	56
57	0.0	0.9	1.8	2.7	3.7	4.6	5.5	6.4	7.4	8.3	9.2	10.1	1.1	57
58	0.0	0.9	1.9	2.8	3.8	4.7	5.7	6.6	7.6	8.5	9.5	0.4	1.4	58
59	0.0	1.0	1.9	2.9	3.9	4.9	5.8	6.8	7.8	8.8	9.7	0.7	1.7	59
60	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.1	60
61	0.0	1.0	2.1	3.1	4.1	5.2	6.2	7.2	8.3	9.3	0.3	1.4	2.5	61
62	0.0	1.1	2.1	3.2	4.3	5.3	6.4	7.5	8.5	9.6	0.7	1.8	2.9	62
63	0.0	1.1	2.2	3.3	4.5	5.5	6.6	7.7	8.8	9.9	1.1	2.2	3.4	63
64	0.0	1.1	2.3	3.4	4.6	5.7	6.9	8.0	9.2	10.3	1.5	2.6	3.9	64
65.0	0.0	1.2	2.4	3.5	4.8	5.9	7.1	8.3	9.5	10.7	11.9	13.1	14.4	65.0
5.5	0.0	1.2	2.4	3.6	4.8	6.0	7.2	8.5	9.7	0.9	2.1	3.4	4.6	5.5
6.0	0.0	1.2	2.5	3.7	4.9	6.1	7.4	8.6	9.9	1.1	2.4	3.6	4.9	6.0
6.5	0.0	1.2	2.5	3.8	5.0	6.3	7.5	8.8	10.1	1.3	2.6	3.9	5.2	6.5
7.0	0.0	1.3	2.6	3.8	5.1	6.4	7.7	9.0	0.3	1.6	2.9	4.2	5.5	7.0
67.5	0.0	1.3	2.6	3.9	5.2	6.5	7.9	9.2	10.5	11.8	13.2	14.5	15.9	67.5
8.0	0.0	1.3	2.7	4.0	5.3	6.7	8.0	9.4	0.7	2.1	3.5	4.8	6.2	8.0
8.5	0.0	1.4	2.7	4.1	5.4	6.8	8.2	9.6	1.0	2.4	3.8	5.2	6.6	8.5
9.0	0.0	1.4	2.8	4.2	5.5	7.0	8.4	9.8	1.2	2.6	4.1	5.5	7.0	9.0
9.5	0.0	1.4	2.9	4.3	5.7	7.2	8.6	10.0	1.5	2.9	4.4	5.9	7.4	9.5
70.0	0.0	1.5	2.9	4.4	5.8	7.3	8.8	10.3	11.8	13.3	14.8	16.3	17.8	70.0
0.5	0.0	1.5	3.0	4.5	6.0	7.5	9.0	0.5	2.1	3.6	5.1	6.7	8.2	0.5
1.0	0.0	1.5	3.1	4.6	6.2	7.7	9.3	0.8	2.4	3.9	5.5	7.1	8.7	1.0
1.5	0.0	1.6	3.2	4.7	6.3	7.9	9.5	1.1	2.7	4.3	5.9	7.8	9.2	1.5
2.0	0.0	1.6	3.2	4.9	6.5	8.1	9.8	1.4	3.0	4.7	6.4	8.1	9.8	2.0
72.5	0.0	1.7	3.3	5.0	6.7	8.3	10.0	11.7	13.4	15.1	16.9	18.6	20.3	72.5
3.0	0.0	1.7	3.4	5.1	6.9	8.6	0.3	2.0	3.8	5.5	7.4	9.1	0.9	3.0
3.5	0.0	1.8	3.5	5.2	7.1	8.8	0.6	2.4	4.2	6.0	7.9	9.7	1.6	3.5
4.0	0.0	1.8	3.6	5.4	7.3	9.1	0.9	2.8	4.6	6.5	8.4	20.3	2.3	4.0
4.5	0.0	1.9	3.7	5.6	7.5	9.4	1.3	3.2	5.1	7.1	9.0	1.0	3.0	4.5
75.0	0.0	1.9	3.8	5.8	7.7	9.7	11.7	13.6	15.6	17.7	19.7	21.7	23.8	75.0
5.5	0.0	2.0	3.9	6.0	8.0	10.0	2.1	4.1	6.2	8.3	20.4	2.5	4.7	5.5
6.0	0.0	2.1	4.0	6.2	8.3	0.4	2.5	4.6	6.8	8.9	1.1	3.3	5.6	6.0
6.5	0.0	2.1	4.2	6.4	8.6	0.8	3.0	5.2	7.4	9.6	1.9	4.2	6.6	6.5
7.0	0.0	2.2	4.4	6.6	8.9	1.2	3.5	5.8	8.1	20.4	2.8	5.2	7.7	7.0

TABLE 39.

Amplitudes.

Latitude.	Declination.													Latitude.
	6°.0	6°.5	7°.0	7°.5	8°.0	8°.5	9°.0	9°.5	10°.0	10°.5	11°.0	11°.5	12°.0	
°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
0	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	0
10	6.1	6.6	7.1	7.6	8.1	8.6	9.1	9.7	0.1	0.7	1.2	1.7	2.2	10
15	6.2	6.7	7.2	7.8	8.3	8.8	9.3	9.8	0.4	0.9	1.4	1.9	2.5	15
20	6.4	6.9	7.4	8.0	8.5	9.1	9.6	10.1	0.7	1.2	1.7	2.3	2.8	20
25	6.6	7.1	7.7	8.3	8.8	9.4	9.9	0.5	1.1	1.6	2.2	2.8	3.3	25
30	6.9	7.5	8.1	8.7	9.3	9.8	10.4	11.0	11.5	12.1	12.7	13.3	13.9	30
32	7.0	7.7	8.3	8.8	9.5	10.0	0.6	1.2	1.8	2.4	3.0	3.6	4.2	32
34	7.2	7.8	8.5	9.0	9.7	0.3	0.8	1.5	2.1	2.7	3.3	3.9	4.5	34
36	7.4	8.0	8.7	9.3	9.9	0.5	1.1	1.8	2.4	3.0	3.6	4.3	4.9	36
38	7.6	8.2	8.9	9.5	10.2	0.8	1.4	2.1	2.7	3.4	4.0	4.7	5.3	38
40	7.8	8.5	9.1	9.8	10.5	11.1	11.7	12.4	13.1	13.8	14.4	15.1	15.7	40
42	8.0	8.8	9.4	10.1	0.8	1.5	2.1	2.8	3.5	4.2	4.8	5.6	6.2	42
44	8.3	9.1	9.7	0.5	1.1	1.9	2.5	3.3	4.0	4.7	5.3	6.1	6.8	44
46	8.6	9.4	10.1	0.8	1.5	2.3	3.0	3.8	4.5	5.2	5.9	6.7	7.4	46
48	9.0	9.7	0.5	1.2	2.0	2.8	3.5	4.3	5.0	5.8	6.6	7.3	8.1	48
50	9.3	10.1	10.9	11.7	12.5	13.3	14.1	14.9	15.7	16.5	17.3	18.1	18.9	50
51	9.5	0.4	1.2	2.0	2.8	3.6	4.4	5.2	6.0	6.8	7.7	8.5	9.3	51
52	9.7	0.6	1.4	2.2	3.1	3.9	4.7	5.6	6.4	7.2	8.1	8.9	9.7	52
53	10.0	0.8	1.7	2.5	3.4	4.2	5.1	5.9	6.8	7.6	8.5	9.4	20.2	53
54	0.2	1.1	2.0	2.8	3.7	4.6	5.4	6.3	7.2	8.1	8.9	9.8	0.7	54
55	10.5	11.4	12.3	13.1	14.0	14.9	15.8	16.7	17.6	18.5	19.4	20.3	21.2	55
56	0.8	1.7	2.6	3.5	4.4	5.3	6.2	7.2	8.1	9.0	9.9	0.9	1.8	56
57	1.1	2.0	2.9	3.9	4.8	5.8	6.7	7.7	8.6	9.6	20.5	1.5	2.4	57
58	1.4	2.3	3.3	4.3	5.2	6.2	7.2	8.2	9.1	20.1	1.1	2.1	3.1	58
59	1.7	2.7	3.7	4.7	5.7	6.7	7.7	8.7	9.7	0.7	1.7	2.8	3.8	59
60	12.1	13.1	14.1	15.1	16.2	17.2	18.2	19.3	20.3	21.4	22.4	23.5	24.6	60
61	2.5	3.5	4.6	5.6	6.7	7.8	8.8	9.9	1.0	2.1	3.1	4.3	5.4	61
62	2.9	3.9	5.1	6.1	7.3	8.4	9.4	20.6	1.7	2.9	3.9	5.2	6.3	62
63	3.4	4.4	5.6	6.7	7.9	9.0	20.1	1.3	2.5	3.7	4.8	6.1	7.2	63
64	3.9	5.0	6.2	7.3	8.5	9.7	0.9	2.1	3.3	4.6	5.7	7.1	8.3	64
65.0	14.4	15.5	16.8	18.0	19.3	20.5	21.7	23.0	24.2	25.6	26.8	28.2	29.5	65.0
5.5	4.6	5.8	7.1	8.3	9.6	0.9	2.2	3.5	4.7	6.1	7.4	8.7	30.1	5.5
6.0	4.9	6.2	7.4	8.7	20.0	1.3	2.6	3.9	5.3	6.6	8.0	9.3	0.7	6.0
6.5	5.2	6.5	7.8	9.1	0.4	1.8	3.1	4.4	5.8	7.2	8.6	30.0	1.4	6.5
7.0	5.5	6.8	8.2	9.5	0.9	2.2	3.6	5.0	6.4	7.8	9.2	0.7	2.1	7.0
67.5	15.9	17.2	18.6	19.9	21.3	22.7	24.1	25.5	27.0	28.4	29.9	31.4	32.9	67.5
8.0	6.2	7.6	9.0	20.4	1.8	3.2	4.7	6.1	7.6	9.1	30.6	2.2	3.7	8.0
8.5	6.6	8.0	9.4	0.9	2.3	3.8	5.3	6.8	8.3	9.8	1.4	3.0	4.6	8.5
9.0	7.0	8.4	9.9	1.4	2.8	4.4	5.9	7.4	9.0	30.6	2.2	3.8	5.5	9.0
9.5	7.4	8.9	20.4	1.9	3.4	5.0	6.5	8.1	9.7	1.4	3.0	4.7	6.4	9.5
70.0	17.8	19.3	20.9	22.4	24.0	25.6	27.2	28.8	30.5	32.2	33.9	35.7	37.4	70.0
0.5	8.2	9.8	1.4	3.0	4.6	6.3	7.9	9.6	1.3	3.1	4.9	6.7	8.5	0.5
1.0	8.7	20.3	2.0	3.6	5.3	7.0	8.7	30.5	2.2	4.0	5.9	7.8	9.7	1.0
1.5	9.2	0.9	2.6	4.3	6.0	7.8	9.5	1.4	3.2	5.0	7.0	8.9	40.9	1.5
2.0	9.8	1.5	3.2	5.0	6.8	8.6	30.4	2.3	4.2	6.1	8.1	40.2	2.3	2.0
72.5	20.3	22.1	23.9	25.7	27.6	29.5	31.4	33.3	35.3	37.3	39.4	41.5	43.7	72.5
3.0	0.9	2.8	4.6	6.5	8.4	30.4	2.4	4.4	6.5	8.6	40.8	3.0	5.3	3.0
3.5	1.6	3.5	5.4	7.4	9.3	1.4	3.4	5.5	7.7	9.9	2.2	4.6	7.0	3.5
4.0	2.3	4.3	6.2	8.3	30.3	2.5	4.6	6.8	9.1	41.4	3.8	6.3	8.9	4.0
4.5	3.0	5.1	7.1	9.3	1.4	3.6	5.8	8.2	40.5	3.0	5.6	8.2	51.1	4.5
75.0	23.8	26.0	28.1	30.3	32.5	34.8	37.2	39.6	42.1	44.8	47.5	50.4	53.5	75.0
5.5	4.7	6.9	9.1	1.4	3.8	6.2	8.7	41.2	3.9	6.7	9.6	2.8	6.2	5.5
6.0	5.6	7.9	30.2	2.6	5.1	7.7	40.3	3.0	5.9	8.9	52.1	5.5	9.3	6.0
6.5	6.6	9.0	1.4	4.0	6.6	9.3	2.1	5.0	8.1	51.3	4.8	8.7	63.0	6.5
7.0	7.7	30.2	2.8	5.5	8.2	41.1	4.1	7.2	50.5	4.1	8.0	62.4	7.6	7.0

TABLE 39.

Amplitudes.

Latitude.	Declination.													Latitude.
	12°.0	12°.5	13°.0	13°.5	14°.0	14°.5	15°.0	15°.5	16°.0	16°.5	17°.0	17°.5	18°.0	
°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
0	12.0	12.5	13.0	13.5	14.0	14.5	15.0	15.5	16.0	16.5	17.0	17.5	18.0	0
10	2.2	2.7	3.2	3.7	4.2	4.7	5.3	5.8	6.3	6.8	7.3	7.9	8.3	10
15	2.5	2.9	3.5	4.0	4.5	5.0	5.6	6.1	6.6	7.1	7.7	8.2	8.7	15
20	2.8	3.3	3.8	4.4	4.9	5.5	6.0	6.5	7.1	7.6	8.1	8.7	9.2	20
25	3.3	3.8	4.4	4.9	5.5	6.1	6.6	7.1	7.7	8.3	8.8	9.4	9.9	25
30	13.9	14.5	15.0	15.6	16.2	16.8	17.4	18.0	18.6	19.2	19.7	20.3	20.9	30
32	4.2	4.8	5.3	6.0	6.6	7.2	7.8	8.4	9.0	9.6	20.2	0.8	1.4	32
34	4.5	5.1	5.7	6.4	7.0	7.6	8.2	8.8	9.5	20.0	0.7	1.3	1.9	34
36	4.9	5.5	6.1	6.8	7.4	8.0	8.7	9.3	20.0	0.5	1.2	1.8	2.5	36
38	5.3	6.0	6.6	7.2	7.9	8.5	9.2	9.8	0.5	1.1	1.8	2.4	3.1	38
40	15.7	16.4	17.1	17.8	18.4	19.1	19.7	20.4	21.1	21.8	22.4	23.1	23.8	40
41	6.0	6.7	7.3	8.0	8.7	9.4	20.0	0.8	1.4	2.1	2.8	3.5	4.2	41
42	6.2	6.9	7.6	8.3	9.0	9.7	0.4	1.1	1.8	2.5	3.2	3.9	4.6	42
43	6.5	7.2	7.9	8.6	9.3	20.0	0.7	1.4	2.2	2.9	3.6	4.3	5.0	43
44	6.8	7.5	8.2	8.9	9.6	0.4	1.1	1.8	2.6	3.3	4.0	4.7	5.4	44
45	17.1	17.8	18.5	19.3	20.0	20.7	21.5	22.2	23.0	23.7	24.4	25.2	25.9	45
46	7.4	8.2	8.9	9.6	0.4	1.1	1.9	2.6	3.4	4.1	4.9	5.7	6.4	46
47	7.7	8.5	9.3	20.0	0.8	1.5	2.3	3.1	3.8	4.6	5.4	6.2	6.9	47
48	8.1	8.9	9.7	0.4	1.2	2.0	2.8	3.6	4.3	5.1	5.9	6.7	7.5	48
49	8.5	9.3	20.1	0.8	1.6	2.4	3.2	4.1	4.9	5.7	6.5	7.3	8.1	49
50	18.9	19.7	20.5	21.3	22.1	22.9	23.7	24.6	25.4	26.2	27.0	27.9	28.7	50
51	9.3	20.1	0.9	1.8	2.6	3.5	4.3	5.1	6.0	6.8	7.6	8.5	9.4	51
52	9.7	0.6	1.4	2.3	3.1	4.0	4.9	5.7	6.6	7.5	8.3	9.2	30.1	52
53	20.2	1.1	1.9	2.8	3.7	4.6	5.5	6.4	7.3	8.2	9.0	30.0	0.9	53
54	0.7	1.6	2.5	3.4	4.3	5.2	6.1	7.1	8.0	8.9	9.8	0.8	1.7	54
55	21.2	22.2	23.1	24.0	24.9	25.9	26.8	27.8	28.7	29.7	30.6	31.6	32.6	55
56	1.8	2.8	3.7	4.7	5.6	6.6	7.6	8.6	9.5	30.5	1.5	2.5	3.6	56
57	2.4	3.4	4.4	5.4	6.4	7.4	8.4	9.4	30.4	1.4	2.5	3.5	4.6	57
58	3.1	4.1	5.1	6.1	7.2	8.2	9.2	30.3	1.3	2.4	3.5	4.6	5.7	58
59	3.8	4.8	5.9	6.9	8.0	9.1	30.2	1.3	2.3	3.5	4.6	5.7	6.9	59
60	24.6	25.6	26.7	27.8	28.9	30.1	31.2	32.3	33.4	34.6	35.8	36.9	38.2	60
61	5.4	6.5	7.6	8.8	9.9	1.1	2.2	3.5	4.6	5.8	7.1	8.3	9.6	61
62	6.3	7.5	8.6	9.8	31.0	2.2	3.4	4.7	5.9	7.2	8.5	9.8	41.2	62
63	7.2	8.5	9.7	31.0	2.2	3.5	4.7	6.1	7.4	8.7	40.1	41.5	2.9	63
64	8.3	9.6	30.9	2.2	3.5	4.8	6.2	7.6	9.0	40.4	1.8	3.3	4.8	64
65.0	29.5	30.8	32.2	33.5	34.9	36.3	37.8	39.2	40.7	42.2	43.8	45.4	47.0	65.0
5.5	30.1	1.5	2.9	4.3	5.7	7.1	8.6	40.1	1.6	3.2	4.8	6.5	8.2	5.5
6.0	0.7	2.2	3.6	5.0	6.5	8.0	9.5	1.1	2.7	4.3	5.9	7.7	9.4	6.0
6.5	1.4	2.9	4.3	5.8	7.3	8.9	40.5	2.1	3.8	5.4	7.1	8.9	50.8	6.5
7.0	2.1	3.6	5.1	6.7	8.2	9.8	1.5	3.2	4.9	6.6	8.4	50.3	2.3	7.0
67.5	32.9	34.4	36.0	37.6	39.2	40.8	42.6	44.3	46.1	47.9	49.8	51.8	53.9	67.5
8.0	3.7	5.3	6.9	8.6	40.2	1.9	3.7	5.5	7.4	9.3	51.3	3.4	5.6	8.0
8.5	4.6	6.2	7.9	9.6	1.3	3.1	4.9	6.8	8.8	50.8	2.9	5.1	7.5	8.5
9.0	5.5	7.2	8.9	40.7	2.5	4.3	6.2	8.2	50.3	2.4	4.6	7.0	9.6	9.0
9.5	6.4	8.2	40.0	1.8	3.7	5.6	7.6	9.7	1.9	4.2	6.5	9.1	61.9	9.5
70.0	37.4	39.3	41.1	43.0	45.0	47.0	49.2	51.4	53.7	56.1	58.7	61.5	64.6	70.0
0.5	8.5	40.4	2.4	4.4	6.4	8.6	50.8	3.2	5.7	8.3	61.1	4.3	7.8	0.5
1.0	9.7	1.7	3.7	5.8	8.0	50.3	2.6	5.2	7.9	60.7	3.9	7.5	71.7	1.0
1.5	40.9	3.0	5.1	7.4	9.7	2.1	4.6	7.4	60.3	3.5	7.1	71.4	6.9	1.5
2.0	2.3	4.4	6.7	9.1	51.5	4.1	6.9	9.9	3.1	6.8	71.1	6.7	90.0	2.0
72.5	43.7	46.0	48.4	50.9	53.6	56.4	59.4	62.7	66.4	70.9	76.5	90.0		72.5
3.0	5.3	7.7	50.3	3.0	5.9	8.9	62.2	6.1	70.6	6.3	90.0			3.0
3.5	7.0	9.6	2.3	5.3	8.4	61.8	5.6	70.3	6.1	90.0				3.5
4.0	8.9	51.7	4.7	7.9	61.4	5.3	9.8	75.9	90.0					4.0
4.5	51.1	4.1	7.3	60.9	4.9	9.5	75.5	90.0						4.5

TABLE 39.

Amplitudes.

Latitude.	Declination.													Latitude.
	18°.0	18°.5	19°.0	19°.5	20°.0	20°.5	21°.0	21°.5	22°.0	22°.5	23°.0	23°.5	24°.0	
°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
0	18.0	18.5	19.0	19.5	20.0	20.5	21.0	21.5	22.0	22.5	23.0	23.5	24.0	0
10	8.3	8.8	9.3	9.8	0.3	0.8	1.3	1.8	2.3	2.9	3.4	3.9	4.4	10
15	8.7	9.2	9.7	20.2	0.7	1.3	1.8	2.3	2.8	3.3	3.9	4.4	4.9	15
20	9.2	9.7	20.3	0.8	1.4	1.9	2.4	3.0	3.5	4.0	4.6	5.1	5.7	20
25	9.9	20.5	1.1	1.6	2.2	2.7	3.3	3.9	4.4	5.0	5.5	6.1	6.7	25
30	20.9	21.5	22.1	22.7	23.3	23.8	24.4	25.0	25.6	26.2	26.8	27.4	28.0	30
32	1.4	2.0	2.6	3.2	3.8	4.4	5.0	5.6	6.2	6.8	7.4	8.0	8.7	32
34	1.9	2.5	3.1	3.8	4.4	5.0	5.6	6.2	6.9	7.5	8.1	8.7	9.4	34
36	2.5	3.1	3.7	4.4	5.0	5.7	6.3	6.9	7.6	8.2	8.9	9.5	30.2	36
38	3.1	3.8	4.4	5.1	5.7	6.4	7.0	7.7	8.4	9.1	9.7	30.4	1.1	38
40	23.9	24.4	25.1	25.8	26.5	27.2	27.9	28.6	29.3	30.0	30.7	31.3	32.1	40
41	4.2	4.8	5.5	6.2	6.9	7.7	8.3	9.1	9.8	0.5	1.2	1.8	2.6	41
42	4.6	5.3	6.0	6.7	7.4	8.1	8.8	9.6	30.3	1.0	1.7	2.4	3.2	42
43	5.0	5.7	6.4	7.2	7.9	8.6	9.3	30.1	0.8	1.6	2.3	3.0	~~3.8~~	43
44	5.4	6.2	6.9	7.7	8.4	9.1	9.8	0.6	1.4	2.2	2.9	3.6	4.4	44
45	25.9	26.7	27.4	28.2	28.9	29.7	30.4	31.2	32.0	32.8	33.5	34.3	35.1	45
46	6.4	7.2	7.9	8.7	9.5	30.3	1.0	1.8	2.6	3.4	4.2	5.0	5.8	46
47	6.9	7.7	8.5	9.3	30.1	0.9	1.7	2.5	3.3	4.1	4.9	5.7	6.6	47
48	7.5	8.3	9.1	9.9	0.7	1.6	2.4	3.2	4.0	4.9	5.7	6.5	7.4	48
49	8.1	8.9	9.7	30.6	1.4	2.3	3.1	4.0	4.8	5.7	6.5	7.4	8.3	49
50	28.7	29.6	30.4	31.3	32.1	33.0	33.9	34.8	35.6	36.5	37.4	38.3	39.2	50
51	9.4	30.3	1.1	2.0	2.9	3.8	4.7	5.6	6.5	7.4	8.4	9.3	40.2	51
52	30.1	1.0	1.9	2.8	3.7	4.7	5.6	6.5	7.5	8.4	9.4	40.3	1.3	52
53	0.9	1.8	2.7	3.7	4.6	5.6	6.6	7.5	8.5	9.5	40.5	1.4	2.5	53
54	1.7	2.7	3.6	4.6	5.6	6.6	7.6	8.6	9.6	40.6	1.7	2.6	3.8	54
55	32.6	33.6	34.6	35.6	36.6	37.6	38.7	39.7	40.8	41.9	42.9	44.0	45.2	55
56	3.6	4.6	5.6	6.7	7.7	8.8	9.8	41.0	2.1	3.2	4.3	5.4	6.7	56
57	4.6	5.6	6.7	7.8	8.9	40.0	41.1	2.3	3.5	4.6	5.8	7.0	8.3	57
58	5.7	6.8	7.9	9.1	40.2	1.4	2.5	3.8	5.0	6.2	7.5	8.8	50.1	58
59	6.9	8.0	9.2	40.4	1.6	2.8	4.1	5.4	6.7	8.0	9.3	50.7	2.2	59
60.0	38.2	39.4	40.6	41.9	43.2	44.5	45.8	47.2	48.6	49.9	51.4	52.9	54.4	60.0
0.5	8.9	40.1	1.4	2.7	4.0	5.4	6.7	8.1	9.6	51.0	2.5	4.1	5.7	0.5
1.0	9.6	0.9	2.2	3.5	4.9	6.3	7.7	9.1	50.6	2.1	3.7	5.3	7.0	1.0
1.5	40.4	1.7	3.0	4.4	5.8	7.3	8.7	50.2	1.7	3.3	5.0	6.7	8.5	1.5
2.0	1.2	2.5	3.9	5.3	6.8	8.3	9.8	1.3	2.9	4.6	6.3	8.1	60.0	2.0
62.5	42.0	43.4	44.9	46.3	47.8	49.4	51.0	52.6	54.2	56.0	57.8	59.7	61.7	62.5
3.0	2.9	4.3	5.9	7.4	8.9	50.5	2.2	3.9	5.6	7.5	9.4	61.4	3.6	3.0
3.5	3.8	5.3	6.9	8.5	50.1	1.7	3.5	5.3	7.1	9.1	61.1	3.4	5.7	3.5
4.0	4.8	6.4	8.0	9.7	1.3	3.0	4.9	6.7	8.7	60.7	3.0	5.5	8.1	4.0
4.5	5.9	7.5	9.2	50.9	2.6	4.5	6.4	8.4	60.5	2.8	5.2	7.8	70.9	4.5
65.0	47.0	48.7	50.4	52.2	54.0	56.0	58.0	60.2	62.5	64.9	67.6	70.6	74.4	65.0
5.5	8.2	50.0	1.8	3.6	5.6	7.6	9.8	2.2	4.7	7.3	70.4	4.1	8.9	5.5
6.0	9.4	1.3	3.2	5.1	7.3	9.4	61.8	4.4	7.1	70.2	3.8	8.6	90.0	6.0
6.5	50.8	2.7	4.7	6.8	9.1	61.4	4.0	6.8	70.0	3.7	8.4	90.0		6.5
7.0	2.3	4.3	6.4	8.7	61.1	3.7	6.5	9.8	3.5	8.3	90.0			7.0
67.5	53.9	56.0	58.3	60.7	63.4	66.2	69.5	73.3	78.2	90.0				67.5
8.0	5.6	7.9	60.3	3.0	5.9	9.2	73.0	8.1	90.0					8.0
8.5	7.5	60.0	2.6	5.6	8.9	72.8	7.9	90.0						8.5
9.0	9.6	2.3	5.3	8.7	72.7	7.7	90.0							9.0
9.5	61.9	5.0	8.4	72.4	7.6	90.0								9.5
70.0	64.6	69.1	72.2	77.4	90.0									70.0
0.5	7.8	71.9	7.2	90.0										0.5
1.0	71.7	7.1	90.0											1.0
1.5	6.9	90.0												1.5
2.0	90.0													2.0

TABLE 39.

Amplitudes.

Latitude.	Declination.													Latitude.
	24°.0	24°.5	25°.0	25°.5	26°.0	26°.5	27°.0	27°.5	28°.0	28°.5	29°.0	29°.5	30°.0	
°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
0	24.0	24.5	25.0	25.5	26.0	26.5	27.0	27.5	28.0	28.5	29.0	29.5	30.0	0
4	4.1	4.6	5.1	5.6	6.1	6.6	7.1	7.6	8.1	8.6	9.1	9.6	0.1	4
8	4.3	4.8	5.3	5.8	6.3	6.8	7.3	7.8	8.3	8.8	9.3	9.8	0.3	8
12	4.6	5.1	5.6	6.1	6.6	7.1	7.6	8.1	8.7	9.2	9.7	30.2	0.7	12
16	5.0	5.6	6.1	6.6	7.1	7.6	8.2	8.7	9.2	9.8	30.3	0.8	1.3	16
20	25.7	26.2	26.7	27.3	27.8	28.3	28.9	29.4	30.0	30.5	31.1	31.6	32.1	20
22	6.0	6.6	7.1	7.7	8.2	8.8	9.3	9.9	0.4	1.0	1.5	2.1	2.6	22
24	6.4	7.0	7.6	8.1	8.7	9.2	9.8	30.4	0.9	1.5	2.0	2.6	3.2	24
26	6.9	7.5	8.1	8.6	9.2	9.7	30.3	0.9	1.5	2.1	2.6	3.2	3.8	26
28	7.4	8.0	8.6	9.2	9.8	30.3	0.9	1.5	2.1	2.7	3.3	3.9	4.5	28
30	28.0	28.6	29.2	29.8	30.4	31.0	31.6	32.2	32.8	33.4	34.0	34.7	35.3	30
31	8.3	8.9	9.5	30.1	0.8	1.4	2.0	2.6	3.2	3.8	4.5	5.1	5.7	31
32	8.7	9.3	9.9	0.5	1.1	1.7	2.4	3.0	3.6	4.2	4.9	5.5	6.1	32
33	9.0	9.6	30.2	0.9	1.5	2.1	2.8	3.4	4.0	4.7	5.3	6.0	6.6	33
34	9.4	30.0	0.6	31.3	1.9	2.6	3.2	3.8	4.5	5.1	5.8	6.4	7.1	34
35	29.8	30.4	31.1	31.7	32.3	33.0	33.6	34.3	35.0	35.6	36.3	36.9	37.6	35
36	30.2	0.8	1.5	2.1	2.8	3.5	4.1	4.8	5.5	6.1	6.8	7.5	8.2	36
37	0.6	1.3	1.9	2.6	3.3	4.0	4.6	5.3	6.0	6.7	7.4	8.1	8.8	37
38	1.1	1.7	2.4	3.1	3.8	4.5	5.2	5.9	6.6	7.3	8.0	8.7	9.4	38
39	1.6	2.2	2.9	3.6	4.3	5.0	5.7	6.5	7.2	7.9	8.6	9.3	40.0	39
40	32.1	32.8	33.5	34.2	34.9	35.6	36.3	37.1	37.8	38.5	39.3	40.0	40.7	40
41	2.6	3.3	4.1	4.8	5.5	6.2	7.0	7.7	8.5	9.2	40.0	0.7	1.5	41
42	3.2	3.9	4.7	5.4	6.1	6.9	7.7	8.4	9.2	9.9	0.7	1.5	2.3	42
43	3.8	4.5	5.3	6.1	6.8	7.6	8.4	9.2	9.9	40.7	1.5	2.3	3.1	43
44	4.4	5.2	6.0	6.8	7.5	8.3	9.1	40.0	40.7	1.6	2.4	3.2	4.0	44
45	35.1	35.9	36.7	37.5	38.3	39.1	39.9	40.8	41.6	42.5	43.3	44.1	45.0	45
46	5.8	6.6	7.5	8.3	9.1	40.0	40.8	1.7	2.5	3.4	4.3	5.1	6.0	46
47	6.6	7.4	8.3	9.1	40.0	0.9	1.7	2.6	3.5	4.4	5.3	6.2	7.1	47
48	7.4	8.3	9.2	40.0	0.9	1.8	2.7	3.6	4.6	5.5	6.4	7.4	8.3	48
49	8.3	9.2	40.1	1.0	1.9	2.8	3.8	4.7	5.7	6.7	7.6	8.6	9.6	49
50	39.2	40.2	41.1	42.0	43.0	43.9	44.9	45.9	46.9	47.9	48.9	50.0	51.1	50
51	40.2	1.2	2.2	3.2	4.1	5.1	6.2	7.2	8.2	9.3	50.4	1.5	2.6	51
52	1.3	2.3	3.3	4.4	5.4	6.4	7.5	8.6	9.7	50.8	2.0	3.1	4.3	52
53	2.5	3.5	4.6	5.7	6.7	7.8	9.0	50.1	51.3	2.5	3.7	4.9	6.2	53
54	3.8	4.9	6.0	7.1	8.2	9.4	50.6	1.8	3.0	4.3	5.6	6.9	8.3	54
55.0	45.2	46.3	47.5	48.6	49.8	51.1	52.3	53.6	54.9	56.3	57.7	59.1	60.7	55.0
5.5	5.9	7.1	8.3	9.5	50.7	2.0	3.3	4.6	6.0	7.4	8.9	60.4	2.0	5.5
6.0	6.7	7.9	9.1	50.4	1.6	2.9	4.3	5.7	7.1	8.6	60.1	1.7	3.4	6.0
6.5	7.5	8.8	50.0	1.3	2.6	3.9	5.4	6.8	8.3	9.9	1.5	3.2	5.0	6.5
7.0	8.3	9.6	0.9	2.2	3.6	5.0	6.5	8.0	9.5	61.2	2.9	4.7	6.6	7.0
57.5	49.2	50.5	51.9	53.2	54.7	56.2	57.7	59.3	60.9	62.6	64.5	66.4	68.5	57.5
8.0	50.1	1.5	2.9	4.3	5.8	7.4	8.9	60.6	2.4	4.2	6.2	8.3	70.7	8.0
8.5	1.1	2.5	4.0	5.5	7.0	8.6	60.3	2.1	3.9	6.0	8.1	70.4	3.1	8.5
9.0	2.2	3.6	5.1	6.7	8.3	60.0	1.8	3.7	5.7	7.9	70.3	3.0	6.2	9.0
9.5	3.3	4.8	6.4	8.0	9.7	1.5	3.4	5.5	7.7	70.1	2.8	5.9	80.1	9.5
60.0	54.4	56.0	57.7	59.4	61.2	63.2	65.2	67.4	69.9	72.6	75.8	80.0	90.0	60.0
0.5	5.7	7.4	9.1	61.0	2.9	5.0	7.2	9.6	72.4	5.8	9.9	90.0		0.5
1.0	7.0	8.8	60.7	2.6	4.7	7.0	9.5	72.3	5.5	9.8	90.0			1.0
1.5	8.5	60.3	2.3	4.4	6.7	9.2	72.0	5.4	9.7	90.0				1.5
2.0	60.0	2.0	4.2	6.5	9.0	71.9	5.2	9.6	90.0					2.0
62.5	61.7	63.9	66.2	68.8	71.7	75.1	9.5	90.0						62.5
3.0	3.6	6.0	8.6	71.5	4.9	9.4	90.0							3.0
3.5	5.7	8.3	71.3	4.8	9.3	90.0								3.5
4.0	8.1	71.1	4.6	9.2	90.0									4.0
4.5	70.9	4.4	9.0	90.0										4.5

TABLE 40.

Correction of the Amplitude as observed on the Apparent Horizon.

Latitude.	Declination.													Latitude.
	0°	5°	10°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	
°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
5	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	5
10	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	10
15	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	15
20	.2	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3	20
24	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	24
28	.3	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	28
32	.4	.4	.4	.4	.4	.4	.4	.5	.5	.5	.5	.5	.5	32
36	.5	.5	.5	.5	.5	.5	.5	.5	.6	.6	.6	.6	.6	36
38	.5	.5	.5	.5	.6	.6	.6	.6	.6	.6	.6	.7	.7	38
40	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	40
42	.6	.6	.6	.6	.6	.7	.7	.7	.7	.7	.8	.8	.8	42
44	.6	.6	.7	.7	.7	.7	.7	.7	.8	.8	.8	.9	.9	44
46	.7	.7	.7	.7	.7	.8	.8	.8	.8	.9	.9	.9	1.0	46
48	.7	.8	.8	.8	.8	.8	.8	.9	.9	1.0	1.0	1.0	.1	48
50	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	1.0	1.1	1.1	1.1	1.3	50
52	.8	.9	.9	.9	.9	1.0	1.0	1.0	.1	.2	.2	.3	.5	52
54	.9	.9	1.0	1.0	1.0	.1	.1	.1	.2	.3	.4	.5	.8	54
56	1.0	1.0	.1	.1	.1	.2	.2	.2	.3	.5	.6	.8	2.2	56
58	.1	.1	.2	.2	.2	.3	.3	.4	.5	.7	.9	2.3	3.2	58
60	1.2	1.2	1.3	1.3	1.3	1.4	1.5	1.6	1.7	2.0	2.4	3.4		60
62	.3	.3	.4	.4	.4	.6	.7	.8	2.1	.5	3.5			62
64	.4	.4	.5	.5	.6	.8	.9	2.2	.6	3.7				64
66	.5	.5	.7	.7	.9	2.0	2.3	.8	3.8					66
68	.6	.7	.9	2.0	2.2	.4	.9	4.0						68
70	1.8	1.9	2.1	2.3	2.6	3.1	4.3							70
72	2.0	2.1	.5	.8	3.3	4.6								72
74	.2	.5	3.0	3.5	4.8									74
76	.6	3.0	.8	5.2										76
78	3.1	.6	5.7											78
80	3.8	4.4												80

TABLE 41.

Natural Sines and Cosines.

Prop. parts		0°		1°		2°		3°		4°			Prop. parts
29	M.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine	N. cos.		2
0	0	00000	100000	01745	99985	03490	99939	05234	99863	06976	99756	60	2
0	1	00029	100000	01774	99984	03519	99938	05263	99861	07005	99754	59	2
1	2	00058	100000	01803	99984	03548	99937	05292	99860	07034	99752	58	2
1	3	00087	100000	01832	99983	03577	99936	05321	99858	07063	99750	57	2
2	4	00116	100000	01862	99983	03606	99935	05350	99857	07092	99748	56	2
2	5	00145	100000	01891	99982	03635	99934	05379	99855	07121	99746	55	2
3	6	00175	100000	01920	99982	03664	99933	05408	99854	07150	99744	54	2
3	7	00204	100000	01949	99981	03693	99932	05437	99852	07179	99742	53	2
4	8	00233	100000	01978	99980	03723	99931	05466	99851	07208	99740	52	2
4	9	00262	100000	02007	99980	03752	99930	05495	99849	07237	99738	51	2
5	10	00291	100000	02036	99979	03781	99929	05524	99847	07266	99736	50	2
5	11	00320	99999	02065	99979	03810	99927	05553	99846	07295	99734	49	2
6	12	00349	99999	02094	99978	03839	99926	05582	99844	07324	99731	48	2
6	13	00378	99999	02123	99977	03868	99925	05611	99842	07353	99729	47	2
7	14	00407	99999	02152	99977	03897	99924	05640	99841	07382	99727	46	2
7	15	00436	99999	02181	99976	03926	99923	05669	99839	07411	99725	45	2
8	16	00465	99999	02211	99976	03955	99922	05698	99838	07440	99723	44	1
8	17	00495	99999	02240	99975	03984	99921	05727	99836	07469	99721	43	1
9	18	00524	99999	02269	99974	04013	99919	05756	99834	07498	99719	42	1
9	19	00553	99998	02298	99974	04042	99918	05785	99833	07527	99716	41	1
10	20	00582	99998	02327	99973	04071	99917	05814	99831	07556	99714	40	1
10	21	00611	99998	02356	99972	04100	99916	05844	99829	07585	99712	39	1
11	22	00640	99998	02385	99972	04129	99915	05873	99827	07614	99710	38	1
11	23	00669	99998	02414	99971	04159	99913	05902	99826	07643	99708	37	1
12	24	00698	99998	02443	99970	04188	99912	05931	99824	07672	99705	36	1
12	25	00727	99997	02472	99969	04217	99911	05960	99822	07701	99703	35	1
13	26	00756	99997	02501	99969	04246	99910	05989	99821	07730	99701	34	1
13	27	00785	99997	02530	99968	04275	99909	06018	99819	07759	99699	33	1
14	28	00814	99997	02560	99967	04304	99907	06047	99817	07788	99696	32	1
14	29	00844	99996	02589	99966	04333	99906	06076	99815	07817	99694	31	1
15	30	00873	99996	02618	99966	04362	99905	06105	99813	07846	99692	30	1
15	31	00902	99996	02647	99965	04391	99904	06134	99812	07875	99689	29	1
15	32	00931	99996	02676	99964	04420	99902	06163	99810	07904	99687	28	1
16	33	00960	99995	02705	99963	04449	99901	06192	99808	07933	99685	27	1
16	34	00989	99995	02734	99963	04478	99900	06221	99806	07962	99683	26	1
17	35	01018	99995	02763	99962	04507	99898	06250	99804	07991	99680	25	1
17	36	01047	99995	02792	99961	04536	99897	06279	99803	08020	99678	24	1
18	37	01076	99994	02821	99960	04565	99896	06308	99801	08049	99676	23	1
18	38	01105	99994	02850	99959	04594	99894	06337	99799	08078	99673	22	1
19	39	01134	99994	02879	99959	04623	99893	06366	99797	08107	99671	21	1
19	40	01164	99993	02908	99958	04653	99892	06395	99795	08136	99668	20	1
20	41	01193	99993	02938	99957	04682	99890	06424	99793	08165	99666	19	1
20	42	01222	99993	02967	99956	04711	99889	06453	99792	08194	99664	18	1
21	43	01251	99992	02996	99955	04740	99888	06482	99790	08223	99661	17	1
21	44	01280	99992	03025	99954	04769	99886	06511	99788	08252	99659	16	1
22	45	01309	99991	03054	99953	04798	99885	06540	99786	08281	99657	15	1
22	46	01338	99991	03083	99952	04827	99883	06569	99784	08310	99654	14	0
23	47	01367	99991	03112	99952	04856	99882	06598	99782	08339	99652	13	0
23	48	01396	99990	03141	99951	04885	99881	06627	99780	08368	99649	12	0
24	49	01425	99990	03170	99950	04914	99879	06656	99778	08397	99647	11	0
24	50	01454	99989	03199	99949	04943	99878	06685	99776	08426	99644	10	0
25	51	01483	99989	03228	99948	04972	99876	06714	99774	08455	99642	9	0
25	52	01513	99989	03257	99947	05001	99875	06743	99772	08484	99639	8	0
26	53	01542	99988	03286	99946	05030	99873	06773	99770	08513	99637	7	0
26	54	01571	99988	03316	99945	05059	99872	06802	99768	08542	99635	6	0
27	55	01600	99987	03345	99944	05088	99870	06831	99766	08571	99632	5	0
27	56	01629	99987	03374	99943	05117	99869	06860	99764	08600	99630	4	0
28	57	01658	99986	03403	99942	05146	99867	06889	99762	08629	99627	3	0
28	58	01687	99986	03432	99941	05175	99866	06918	99760	08658	99625	2	0
29	59	01716	99985	03461	99940	05205	99864	06947	99758	08687	99622	1	0
29	60	01745	99985	03490	99939	05234	99863	06976	99756	08716	99619	0	0
		N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	M.	
		89°		88°		87°		86°		85°			

TABLE 41.

Natural Sines and Cosines.

Prop. parts 29		5°		6°		7°		8°		9°			Prop. parts 4
	M.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.		
0	0	08716	99619	10453	99452	12187	99255	13917	99027	15643	98769	60	4
0	1	08745	99617	10482	99449	12216	99251	13946	99023	15672	98764	59	4
1	2	08774	99614	10511	99446	12245	99248	13975	99019	15701	98760	58	4
1	3	08803	99612	10540	99443	12274	99244	14004	99015	15730	98755	57	4
2	4	08831	99609	10569	99440	12302	99240	14033	99011	15758	98751	56	4
2	5	08860	99607	10597	99437	12331	99237	14061	99006	15787	98746	55	4
3	6	08889	99604	10626	99434	12360	99233	14090	99002	15816	98741	54	4
3	7	08918	99602	10655	99431	12389	99230	14119	98998	15845	98737	53	4
4	8	08947	99599	10684	99428	12418	99226	14148	98994	15873	98732	52	3
4	9	08976	99596	10713	99424	12447	99222	14177	98990	15902	98728	51	3
5	10	09005	99594	10742	99421	12476	99219	14205	98986	15931	98723	50	3
5	11	09034	99591	10771	99418	12504	99215	14234	98982	15959	98718	49	3
6	12	09063	99588	10800	99415	12533	99211	14263	98978	15988	98714	48	3
6	13	09092	99586	10829	99412	12562	99208	14292	98973	16017	98709	47	3
7	14	09121	99583	10858	99409	12591	99204	14320	98969	16046	98704	46	3
7	15	09150	99580	10887	99406	12620	99200	14349	98965	16074	98700	45	3
8	16	09179	99578	10916	99402	12649	99197	14378	98961	16103	98695	44	3
8	17	09208	99575	10945	99399	12678	99193	14407	98957	16132	98690	43	3
9	18	09237	99572	10973	99396	12706	99189	14436	98953	16160	98686	42	3
9	19	09266	99570	11002	99393	12735	99186	14464	98948	16189	98681	41	3
10	20	09295	99567	11031	99390	12764	99182	14493	98944	16218	98676	40	3
10	21	09324	99564	11060	99386	12793	99178	14522	98940	16246	98671	39	3
11	22	09353	99562	11089	99383	12822	99175	14551	98936	16275	98667	38	3
11	23	09382	99559	11118	99380	12851	99171	14580	98931	16304	98662	37	2
12	24	09411	99556	11147	99377	12880	99167	14608	98927	16333	98657	36	2
12	25	09440	99553	11176	99374	12908	99163	14637	98923	16361	98652	35	2
13	26	09469	99551	11205	99370	12937	99160	14666	98919	16390	98648	34	2
13	27	09498	99548	11234	99367	12966	99156	14695	98914	16419	98643	33	2
14	28	09527	99545	11263	99364	12995	99152	14723	98910	16447	98638	32	2
14	29	09556	99542	11291	99360	13024	99148	14752	98906	16476	98633	31	2
15	30	09585	99540	11320	99357	13053	99144	14781	98902	16505	98629	30	2
15	31	09614	99537	11349	99354	13081	99141	14810	98897	16533	98624	29	2
15	32	09642	99534	11378	99351	13110	99137	14838	98893	16562	98619	28	2
16	33	09671	99531	11407	99347	13139	99133	14867	98889	16591	98614	27	2
16	34	09700	99528	11436	99344	13168	99129	14896	98884	16620	98609	26	2
17	35	09729	99526	11465	99341	13197	99125	14925	98880	16648	98604	25	2
17	36	09758	99523	11494	99337	13226	99122	14954	98876	16677	98600	24	2
18	37	09787	99520	11523	99334	13254	99118	14982	98871	16706	98595	23	2
18	38	09816	99517	11552	99331	13283	99114	15011	98867	16734	98590	22	1
19	39	09845	99514	11580	99327	13312	99110	15040	98863	16763	98585	21	1
19	40	09874	99511	11609	99324	13341	99106	15069	98858	16792	98580	20	1
20	41	09903	99508	11638	99320	13370	99102	15097	98854	16820	98575	19	1
20	42	09932	99506	11667	99317	13399	99098	15126	98849	16849	98570	18	1
21	43	09961	99503	11696	99314	13427	99094	15155	98845	16878	98565	17	1
21	44	09990	99500	11725	99310	13456	99091	15184	98841	16906	98561	16	1
22	45	10019	99497	11754	99307	13485	99087	15212	98836	16935	98556	15	1
22	46	10048	99494	11783	99303	13514	99083	15241	98832	16964	98551	14	1
23	47	10077	99491	11812	99300	13543	99079	15270	98827	16992	98546	13	1
23	48	10106	99488	11840	99297	13572	99075	15299	98823	17021	98541	12	1
24	49	10135	99485	11869	99293	13600	99071	15327	98818	17050	98536	11	1
24	50	10164	99482	11898	99290	13629	99067	15356	98814	17078	98531	10	1
25	51	10192	99479	11927	99286	13658	99063	15385	98809	17107	98526	9	1
25	52	10221	99476	11956	99283	13687	99059	15414	98805	17136	98521	8	1
26	53	10250	99473	11985	99279	13716	99055	15442	98800	17164	98516	7	0
26	54	10279	99470	12014	99276	13744	99051	15471	98796	17193	98511	6	0
27	55	10308	99467	12043	99272	13773	99047	15500	98791	17222	98506	5	0
27	56	10337	99464	12071	99269	13802	99043	15529	98787	17250	98501	4	0
28	57	10366	99461	12100	99265	13831	99039	15557	98782	17279	98496	3	0
28	58	10395	99458	12129	99262	13860	99035	15586	98778	17308	98491	2	0
29	59	10424	99455	12158	99258	13889	99031	15615	98773	17336	98486	1	0
29	60	10453	99452	12187	99255	13917	99027	15643	98769	17365	98481	0	0
		N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	M.	
		84°		83°		82°		81°		80°			

TABLE 41.

Natural Sines and Cosines.

Prop. parts		10°		11°		12°		13°		14°			Prop. parts
28	M.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.		6
0	0	17365	98481	19081	98163	20791	97815	22495	97437	24192	97030	60	6
0	1	17393	98476	19109	98157	20820	97809	22523	97430	24220	97023	59	6
1	2	17422	98471	19138	98152	20848	97803	22552	97424	24249	97015	58	6
1	3	17451	98466	19167	98146	20877	97797	22580	97417	24277	97008	57	6
2	4	17479	98461	19195	98140	20905	97791	22608	97411	24305	97001	56	6
2	5	17508	98455	19224	98135	20933	97784	22637	97404	24333	96994	55	6
3	6	17537	98450	19252	98129	20962	97778	22665	97398	24362	96987	54	5
3	7	17565	98445	19281	98124	20990	97772	22693	97391	24390	96980	53	5
4	8	17594	98440	19309	98118	21019	97766	22722	97384	24418	96973	52	5
4	9	17623	98435	19338	98112	21047	97760	22750	97378	24446	96966	51	5
5	10	17651	98430	19366	98107	21076	97754	22778	97371	24474	96959	50	5
5	11	17680	98425	19395	98101	21104	97748	22807	97365	24503	96952	49	5
6	12	17708	98420	19423	98096	21132	97742	22835	97358	24531	96945	48	5
6	13	17737	98414	19452	98090	21161	97735	22863	97351	24559	96937	47	5
7	14	17766	98409	19481	98084	21189	97729	22892	97345	24587	96930	46	5
7	15	17794	98404	19509	98079	21218	97723	22920	97338	24615	96923	45	5
7	16	17823	98399	19538	98073	21246	97717	22948	97331	24644	96916	44	4
8	17	17852	98394	19566	98067	21275	97711	22977	97325	24672	96909	43	4
8	18	17880	98389	19595	98061	21303	97705	23005	97318	24700	96902	42	4
9	19	17909	98383	19623	98056	21331	97698	23033	97311	24728	96894	41	4
9	20	17937	98378	19652	98050	21360	97692	23062	97304	24756	96887	40	4
10	21	17966	98373	19680	98044	21388	97686	23090	97298	24784	96880	39	4
10	22	17995	98368	19709	98039	21417	97680	23118	97291	24813	96873	38	4
11	23	18023	98362	19737	98033	21445	97673	23146	97284	24841	96866	37	4
11	24	18052	98357	19766	98027	21474	97667	23175	97278	24869	96858	36	4
12	25	18081	98352	19794	98021	21502	97661	23203	97271	24897	96851	35	4
12	26	18109	98347	19823	98016	21530	97655	23231	97264	24925	96844	34	3
13	27	18138	98341	19851	98010	21559	97648	23260	97257	24954	96837	33	3
13	28	18166	98336	19880	98004	21587	97642	23288	97251	24982	96829	32	3
14	29	18195	98331	19908	97998	21616	97636	23316	97244	25010	96822	31	3
14	30	18224	98325	19937	97992	21644	97630	23345	97237	25038	96815	30	3
14	31	18252	98320	19965	97987	21672	97623	23373	97230	25066	96807	29	3
15	32	18281	98315	19994	97981	21701	97617	23401	97223	25094	96800	28	3
15	33	18309	98310	20022	97975	21729	97611	23429	97217	25122	96793	27	3
16	34	18338	98304	20051	97969	21758	97604	23458	97210	25151	96786	26	3
16	35	18367	98299	20079	97963	21786	97598	23486	97203	25179	96778	25	3
17	36	18395	98294	20108	97958	21814	97592	23514	97196	25207	96771	24	2
17	37	18424	98288	20136	97952	21843	97585	23542	97189	25235	96764	23	2
18	38	18452	98283	20165	97946	21871	97579	23571	97182	25263	96756	22	2
18	39	18481	98277	20193	97940	21899	97573	23599	97176	25291	96749	21	2
19	40	18509	98272	20222	97934	21928	97566	23627	97169	25320	96742	20	2
19	41	18538	98267	20250	97928	21956	97560	23656	97162	25348	96734	19	2
20	42	18567	98261	20279	97922	21985	97553	23684	97155	25376	96727	18	2
20	43	18595	98256	20307	97916	22013	97547	23712	97148	25404	96719	17	2
21	44	18624	98250	20336	97910	22041	97541	23740	97141	25432	96712	16	2
21	45	18652	98245	20364	97905	22070	97534	23769	97134	25460	96705	15	2
21	46	18681	98240	20393	97899	22098	97528	23797	97127	25488	96697	14	1
22	47	18710	98234	20421	97893	22126	97521	23825	97120	25516	96690	13	1
22	48	18738	98229	20450	97887	22155	97515	23853	97113	25545	96682	12	1
23	49	18767	98223	20478	97881	22183	97508	23882	97106	25573	96675	11	1
23	50	18795	98218	20507	97875	22212	97502	23910	97100	25601	96667	10	1
24	51	18824	98212	20535	97869	22240	97496	23938	97093	25629	96660	9	1
24	52	18852	98207	20563	97863	22268	97489	23966	97086	25657	96653	8	1
25	53	18881	98201	20592	97857	22297	97483	23995	97079	25685	96645	7	1
25	54	18910	98196	20620	97851	22325	97476	24023	97072	25713	96638	6	1
26	55	18938	98190	20649	97845	22353	97470	24051	97065	25741	96630	5	1
26	56	18967	98185	20677	97839	22382	97463	24079	97058	25769	96623	4	0
27	57	18995	98179	20706	97833	22410	97457	24108	97051	25798	96615	3	0
27	58	19024	98174	20734	97827	22438	97450	24136	97044	25826	96608	2	0
28	59	19052	98168	20763	97821	22467	97444	24164	97037	25854	96600	1	0
28	60	19081	98163	20791	97815	22495	97437	24192	97030	25882	96593	0	0
		N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	M.	
		79°		78°		77°		76°		75°			

TABLE 41.

Natural Sines and Cosines.

Prop. parts 27		15°		16°		17°		18°		19°			Prop. parts 9
	M.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.		
0	0	25882	96593	27564	96126	29237	95630	30902	95106	32557	94552	60	9
0	1	25910	96585	27592	96118	29265	95622	30929	95097	32584	94542	59	9
1	2	25938	96578	27620	96110	29293	95613	30957	95088	32612	94533	58	9
1	3	25966	96570	27648	96102	29321	95605	30985	95079	32639	94523	57	9
2	4	25994	96562	27676	96094	29348	95596	31012	95070	32667	94514	56	8
2	5	26022	96555	27704	96086	29376	95588	31040	95061	32694	94504	55	8
3	6	26050	96547	27731	96078	29404	95579	31068	95052	32722	94495	54	8
3	7	26079	96540	27759	96070	29432	95571	31095	95043	32749	94485	53	8
4	8	26107	96532	27787	96062	29460	95562	31123	95033	32777	94476	52	8
4	9	26135	96524	27815	96054	29487	95554	31151	95024	32804	94466	51	8
5	10	26163	96517	27843	96046	29515	95545	31178	95015	32832	94457	50	8
5	11	26191	96509	27871	96037	29543	95536	31206	95006	32859	94447	49	7
5	12	26219	96502	27899	96029	29571	95528	31233	94997	32887	94438	48	7
6	13	26247	96494	27927	96021	29599	95519	31261	94988	32914	94428	47	7
6	14	26275	96486	27955	96013	29626	95511	31289	94979	32942	94418	46	7
7	15	26303	96479	27983	96005	29654	95502	31316	94970	32969	94409	45	7
7	16	26331	96471	28011	95997	29682	95493	31344	94961	32997	94399	44	7
8	17	26359	96463	28039	95989	29710	95485	31372	94952	33024	94390	43	6
8	18	26387	96456	28067	95981	29737	95476	31399	94943	33051	94380	42	6
9	19	26415	96448	28095	95972	29765	95467	31427	94933	33079	94370	41	6
9	20	26443	96440	28123	95964	29793	95459	31454	94924	33106	94361	40	6
9	21	26471	96433	28150	95956	29821	95450	31482	94915	33134	94351	39	6
10	22	26500	96425	28178	95948	29849	95441	31510	94906	33161	94342	38	6
10	23	26528	96417	28206	95940	29876	95433	31537	94897	33189	94332	37	6
11	24	26556	96410	28234	95931	29904	95424	31565	94888	33216	94322	36	5
11	25	26584	96402	28262	95923	29932	95415	31593	94878	33244	94313	35	5
12	26	26612	96394	28290	95915	29960	95407	31620	94869	33271	94303	34	5
12	27	26640	96386	28318	95907	29987	95398	31648	94860	33298	94293	33	5
13	28	26668	96379	28346	95898	30015	95389	31675	94851	33326	94284	32	5
13	29	26696	96371	28374	95890	30043	95380	31703	94842	33353	94274	31	5
14	30	26724	96363	28402	95882	30071	95372	31730	94832	33381	94264	30	5
14	31	26752	96355	28429	95874	30098	95363	31758	94823	33408	94254	29	4
14	32	26780	96347	28457	95865	30126	95354	31786	94814	33436	94245	28	4
15	33	26808	96340	28485	95857	30154	95345	31813	94805	33463	94235	27	4
15	34	26836	96332	28513	95849	30182	95337	31841	94795	33490	94225	26	4
16	35	26864	96324	28541	95841	30209	95328	31868	94786	33518	94215	25	4
16	36	26892	96316	28569	95832	30237	95319	31896	94777	33545	94206	24	4
17	37	26920	96308	28597	95824	30265	95310	31923	94768	33573	94196	23	3
17	38	26948	96301	28625	95816	30292	95301	31951	94758	33600	94186	22	3
18	39	26976	96293	28652	95807	30320	95293	31979	94749	33627	94176	21	3
18	40	27004	96285	28680	95799	30348	95284	32006	94740	33655	94167	20	3
18	41	27032	96277	28708	95791	30376	95275	32034	94730	33682	94157	19	3
19	42	27060	96269	28736	95782	30403	95266	32061	94721	33710	94147	18	3
19	43	27088	96261	28764	95774	30431	95257	32089	94712	33737	94137	17	3
20	44	27116	96253	28792	95766	30459	95248	32116	94702	33764	94127	16	2
20	45	27144	96246	28820	95757	30486	95240	32144	94693	33792	94118	15	2
21	46	27172	96238	28847	95749	30514	95231	32171	94684	33819	94108	14	2
21	47	27200	96230	28875	95740	30542	95222	32199	94674	33846	94098	13	2
22	48	27228	96222	28903	95732	30570	95213	32227	94665	33874	94088	12	2
22	49	27256	96214	28931	95724	30597	95204	32254	94656	33901	94078	11	2
23	50	27284	96206	28959	95715	30625	95195	32282	94646	33929	94068	10	2
23	51	27312	96198	28987	95707	30653	95186	32309	94637	33956	94058	9	1
23	52	27340	96190	29015	95698	30680	95177	32337	94627	33983	94049	8	1
24	53	27368	96182	29042	95690	30708	95168	32364	94618	34011	94039	7	1
24	54	27396	96174	29070	95681	30736	95159	32392	94609	34038	94029	6	1
25	55	27424	96166	29098	95673	30763	95150	32419	94599	34065	94019	5	1
25	56	27452	96158	29126	95664	30791	95142	32447	94590	34093	94009	4	1
26	57	27480	96150	29154	95656	30819	95133	32474	94580	34120	93999	3	0
26	58	27508	96142	29182	95647	30846	95124	32502	94571	34147	93989	2	0
27	59	27536	96134	29209	95639	30874	95115	32529	94561	34175	93979	1	0
27	60	27564	96126	29237	95630	30902	95106	32557	94552	34202	93969	0	0
		N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	M.	
		74°		73°		72°		71°		70°			

TABLE 41.

Natural Sines and Cosines.

Prop. parts 27		20°		21°		22°		23°		24°			Prop. parts 11
	M.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.		
0	0	34202	93969	35837	93358	37461	92718	39073	92050	40674	91355	60	11
0	1	34229	93959	35864	93348	37488	92707	39100	92039	40700	91343	59	11
1	2	34257	93949	35891	93337	37515	92697	39127	92028	40727	91331	58	11
1	3	34284	93939	35918	93327	37542	92686	39153	92016	40753	91319	57	10
2	4	34311	93929	35945	93316	37569	92675	39180	92005	40780	91307	56	10
2	5	34339	93919	35973	93306	37595	92664	39207	91994	40806	91295	55	10
3	6	34366	93909	36000	93295	37622	92653	39234	91982	40833	91283	54	10
3	7	34393	93899	36027	93285	37649	92642	39260	91971	40860	91272	53	10
4	8	34421	93889	36054	93274	37676	92631	39287	91959	40886	91260	52	10
4	9	34448	93879	36081	93264	37703	92620	39314	91948	40913	91248	51	9
5	10	34475	93869	36108	93253	37730	92609	39341	91936	40939	91236	50	9
5	11	34503	93859	36135	93243	37757	92598	39367	91925	40966	91224	49	9
5	12	34530	93849	36162	93232	37784	92587	39394	91914	40992	91212	48	9
6	13	34557	93839	36190	93222	37811	92576	39421	91902	41019	91200	47	9
6	14	34584	93829	36217	93211	37838	92565	39448	91891	41045	91188	46	8
7	15	34612	93819	36244	93201	37865	92554	39474	91879	41072	91176	45	8
7	16	34639	93809	36271	93190	37892	92543	39501	91868	41098	91164	44	8
8	17	34666	93799	36298	93180	37919	92532	39528	91856	41125	91152	43	8
8	18	34694	93789	36325	93169	37946	92521	39555	91845	41151	91140	42	8
9	19	34721	93779	36352	93159	37973	92510	39581	91833	41178	91128	41	8
9	20	34748	93769	36379	93148	37999	92499	39608	91822	41204	91116	40	7
9	21	34775	93759	36406	93137	38026	92488	39635	91810	41231	91104	39	7
10	22	34803	93748	36434	93127	38053	92477	39661	91799	41257	91092	38	7
10	23	34830	93738	36461	93116	38080	92466	39688	91787	41284	91080	37	7
11	24	34857	93728	36488	93106	38107	92455	39715	91775	41310	91068	36	7
11	25	34884	93718	36515	93095	38134	92444	39741	91764	41337	91056	35	6
12	26	34912	93708	36542	93084	38161	92432	39768	91752	41363	91044	34	6
12	27	34939	93698	36569	93074	38188	92421	39795	91741	41390	91032	33	6
13	28	34966	93688	36596	93063	38215	92410	39822	91729	41416	91020	32	6
13	29	34993	93677	36623	93052	38241	92399	39848	91718	41443	91008	31	6
14	30	35021	93667	36650	93042	38268	92388	39875	91706	41469	90996	30	6
14	31	35048	93657	36677	93031	38295	92377	39902	91694	41496	90984	29	5
14	32	35075	93647	36704	93020	38322	92366	39928	91683	41522	90972	28	5
15	33	35102	93637	36731	93010	38349	92355	39955	91671	41549	90960	27	5
15	34	35130	93626	36758	92999	38376	92343	39982	91660	41575	90948	26	5
16	35	35157	93616	36785	92988	38403	92332	40008	91648	41602	90936	25	5
16	36	35184	93606	36812	92978	38430	92321	40035	91636	41628	90924	24	4
17	37	35211	93596	36839	92967	38456	92310	40062	91625	41655	90911	23	4
17	38	35239	93585	36867	92956	38483	92299	40088	91613	41681	90899	22	4
18	39	35266	93575	36894	92945	38510	92287	40115	91601	41707	90887	21	4
18	40	35293	93565	36921	92935	38537	92276	40141	91590	41734	90875	20	4
18	41	35320	93555	36948	92924	38564	92265	40168	91578	41760	90863	19	3
19	42	35347	93544	36975	92913	38591	92254	40195	91566	41787	90851	18	3
19	43	35375	93534	37002	92902	38617	92243	40221	91555	41813	90839	17	3
20	44	35402	93524	37029	92892	38644	92231	40248	91543	41840	90826	16	3
20	45	35429	93514	37056	92881	38671	92220	40275	91531	41866	90814	15	3
21	46	35456	93503	37083	92870	38698	92209	40301	91519	41892	90802	14	3
21	47	35484	93493	37110	92859	38725	92198	40328	91508	41919	90790	13	2
22	48	35511	93483	37137	92849	38752	92186	40355	91496	41945	90778	12	2
22	49	35538	93472	37164	92838	38778	92175	40381	91484	41972	90766	11	2
23	50	35565	93462	37191	92827	38805	92164	40408	91472	41998	90753	10	2
23	51	35592	93452	37218	92816	38832	92152	40434	91461	42024	90741	9	2
23	52	35619	93441	37245	92805	38859	92141	40461	91449	42051	90729	8	1
24	53	35647	93431	37272	92794	38886	92130	40488	91437	42077	90717	7	1
24	54	35674	93420	37299	92784	38912	92119	40514	91425	42104	90704	6	1
25	55	35701	93410	37326	92773	38939	92107	40541	91414	42130	90692	5	1
25	56	35728	93400	37353	92762	38966	92096	40567	91402	42156	90680	4	1
26	57	35755	93389	37380	92751	38993	92085	40594	91390	42183	90668	3	1
26	58	35782	93379	37407	92740	39020	92073	40621	91378	42209	90655	2	0
27	59	35810	93368	37434	92729	39046	92062	40647	91366	42235	90643	1	0
27	60	35837	93358	37461	92718	39073	92050	40674	91355	42262	90631	0	0
		N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	M.	
		69°		68°		67°		66°		65°			

TABLE 41.

Natural Sines and Cosines.

Prop. parts 26	M.	25°		26°		27°		28°		29°			Prop. parts 14
		N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.		
0	0	42262	90631	43837	89879	45399	89101	46947	88295	48481	87462	60	14
0	1	42288	90618	43863	89867	45425	89087	46973	88281	48506	87448	59	14
1	2	42315	90606	43889	89854	45451	89074	46999	88267	48532	87434	58	14
1	3	42341	90594	43916	89841	45477	89061	47024	88254	48557	87420	57	13
2	4	42367	90582	43942	89828	45503	89048	47050	88240	48583	87406	56	13
2	5	42394	90569	43968	89816	45529	89035	47076	88226	48608	87391	55	13
3	6	42420	90557	43994	89803	45554	89021	47101	88213	48634	87377	54	13
3	7	42446	90545	44020	89790	45580	89008	47127	88199	48659	87363	53	12
3	8	42473	90532	44046	89777	45606	88995	47153	88185	48684	87349	52	12
4	9	42499	90520	44072	89764	45632	88981	47178	88172	48710	87335	51	12
4	10	42525	90507	44098	89752	45658	88968	47204	88158	48735	87321	50	12
5	11	42552	90495	44124	89739	45684	88955	47229	88144	48761	87306	49	11
5	12	42578	90483	44151	89726	45710	88942	47255	88130	48786	87292	48	11
6	13	42604	90470	44177	89713	45736	88928	47281	88117	48811	87278	47	11
6	14	42631	90458	44203	89700	45762	88915	47306	88103	48837	87264	46	11
7	15	42657	90446	44229	89687	45787	88902	47332	88089	48862	87250	45	11
7	16	42683	90433	44255	89674	45813	88888	47358	88075	48888	87235	44	10
7	17	42709	90421	44281	89662	45839	88875	47383	88062	48913	87221	43	10
8	18	42736	90408	44307	89649	45865	88862	47409	88048	48938	87207	42	10
8	19	42762	90396	44333	89636	45891	88848	47434	88034	48964	87193	41	10
9	20	42788	90383	44359	89623	45917	88835	47460	88020	48989	87178	40	9
9	21	42815	90371	44385	89610	45942	88822	47486	88006	49014	87164	39	9
10	22	42841	90358	44411	89597	45968	88808	47511	87993	49040	87150	38	9
10	23	42867	90346	44437	89584	45994	88795	47537	87979	49065	87136	37	9
10	24	42894	90334	44464	89571	46020	88782	47562	87965	49090	87121	36	8
11	25	42920	90321	44490	89558	46046	88768	47588	87951	49116	87107	35	8
11	26	42946	90309	44516	89545	46072	88755	47614	87937	49141	87093	34	8
12	27	42972	90296	44542	89532	46097	88741	47639	87923	49166	87079	33	8
12	28	42999	90284	44568	89519	46123	88728	47665	87909	49192	87064	32	7
13	29	43025	90271	44594	89506	46149	88715	47690	87896	49217	87050	31	7
13	30	43051	90259	44620	89493	46175	88701	47716	87882	49242	87036	30	7
13	31	43077	90246	44646	89480	46201	88688	47741	87868	49268	87021	29	7
14	32	43104	90233	44672	89467	46226	88674	47767	87854	49293	87007	28	7
14	33	43130	90221	44698	89454	46252	88661	47793	87840	49318	86993	27	6
15	34	43156	90208	44724	89441	46278	88647	47818	87826	49344	86978	26	6
15	35	43182	90196	44750	89428	46304	88634	47844	87812	49369	86964	25	6
16	36	43209	90183	44776	89415	46330	88620	47869	87798	49394	86949	24	6
16	37	43235	90171	44802	89402	46355	88607	47895	87784	49419	86935	23	5
16	38	43261	90158	44828	89389	46381	88593	47920	87770	49445	86921	22	5
17	39	43287	90146	44854	89376	46407	88580	47946	87756	49470	86906	21	5
17	40	43313	90133	44880	89363	46433	88566	47971	87743	49495	86892	20	5
18	41	43340	90120	44906	89350	46458	88553	47997	87729	49521	86878	19	4
18	42	43366	90108	44932	89337	46484	88539	48022	87715	49546	86863	18	4
19	43	43392	90095	44958	89324	46510	88526	48048	87701	49571	86849	17	4
19	44	43418	90082	44984	89311	46536	88512	48073	87687	49596	86834	16	4
20	45	43445	90070	45010	89298	46561	88499	48099	87673	49622	86820	15	4
20	46	43471	90057	45036	89285	46587	88485	48124	87659	49647	86805	14	3
20	47	43497	90045	45062	89272	46613	88472	48150	87645	49672	86791	13	3
21	48	43523	90032	45088	89259	46639	88458	48175	87631	49697	86777	12	3
21	49	43549	90019	45114	89245	46664	88445	48201	87617	49723	86762	11	3
22	50	43575	90007	45140	89232	46690	88431	48226	87603	49748	86748	10	2
22	51	43602	89994	45166	89219	46716	88417	48252	87589	49773	86733	9	2
23	52	43628	89981	45192	89206	46742	88404	48277	87575	49798	86719	8	2
23	53	43654	89968	45218	89193	46767	88390	48303	87561	49824	86704	7	2
23	54	43680	89956	45243	89180	46793	88377	48328	87546	49849	86690	6	1
24	55	43706	89943	45269	89167	46819	88363	48354	87532	49874	86675	5	1
24	56	43733	89930	45295	89153	46844	88349	48379	87518	49899	86661	4	1
25	57	43759	89918	45321	89140	46870	88336	48405	87504	49924	86646	3	1
25	58	43785	89905	45347	89127	46896	88322	48430	87490	49950	86632	2	0
26	59	43811	89892	45373	89114	46921	88308	48456	87476	49975	86617	1	0
26	60	43837	89879	45399	89101	46947	88295	48481	87462	50000	86603	0	0
		N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	M.	
		64°		63°		62°		61°		60°			

TABLE 41.

Natural Sines and Cosines.

Prop. parts.		30°		31°		32°		33°		34°			Prop. parts.
25	M.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.		16
0	0	50000	86603	51504	85717	52992	84805	54464	83867	55919	82904	60	16
0	1	50025	86588	51529	85702	53017	84789	54488	83851	55943	82887	59	16
1	2	50050	86573	51554	85687	53041	84774	54513	83835	55968	82871	58	15
1	3	50076	86559	51579	85672	53066	84759	54537	83819	55992	82855	57	15
2	4	50101	86544	51604	85657	53091	84743	54561	83804	56016	82839	56	15
2	5	50126	86530	51628	85642	53115	84728	54586	83788	56040	82822	55	15
3	6	50151	86515	51653	85627	53140	84712	54610	83772	56064	82806	54	14
3	7	50176	86501	51678	85612	53164	84697	54635	83756	56088	82790	53	14
3	8	50201	86486	51703	85597	53189	84681	54659	83740	56112	82773	52	14
4	9	50227	86471	51728	85582	53214	84666	54683	83724	56136	82757	51	14
4	10	50252	86457	51753	85567	53238	84650	54708	83708	56160	82741	50	13
5	11	50277	86442	51778	85551	53263	84635	54732	83692	56184	82724	49	13
5	12	50302	86427	51803	85536	53288	84619	54756	83676	56208	82708	48	13
5	13	50327	86413	51828	85521	53312	84604	54781	83660	56232	82692	47	13
6	14	50352	86398	51852	85506	53337	84588	54805	83645	56256	82675	46	12
6	15	50377	86384	51877	85491	53361	84573	54829	83629	56280	82659	45	12
7	16	50403	86369	51902	85476	53386	84557	54854	83613	56305	82643	44	12
7	17	50428	86354	51927	85461	53411	84542	54878	83597	56329	82626	43	11
8	18	50453	86340	51952	85446	53435	84526	54902	83581	56353	82610	42	11
8	19	50478	86325	51977	85431	53460	84511	54927	83565	56377	82593	41	11
8	20	50503	86310	52002	85416	53484	84495	54951	83549	56401	82577	40	11
9	21	50528	86295	52026	85401	53509	84480	54975	83533	56425	82561	39	10
9	22	50553	86281	52051	85385	53534	84464	54999	83517	56449	82544	38	10
10	23	50578	86266	52076	85370	53558	84448	55024	83501	56473	82528	37	10
10	24	50603	86251	52101	85355	53583	84433	55048	83485	56497	82511	36	10
10	25	50628	86237	52126	85340	53607	84417	55072	83469	56521	82495	35	9
11	26	50654	86222	52151	85325	53632	84402	55097	83453	56545	82478	34	9
11	27	50679	86207	52175	85310	53656	84386	55121	83437	56569	82462	33	9
12	28	50704	86192	52200	85294	53681	84370	55145	83421	56593	82446	32	9
12	29	50729	86178	52225	85279	53705	84355	55169	83405	56617	82429	31	8
13	30	50754	86163	52250	85264	53730	84339	55194	83389	56641	82413	30	8
13	31	50779	86148	52275	85249	53754	84324	55218	83373	56665	82396	29	8
13	32	50804	86133	52299	85234	53779	84308	55242	83356	56689	82380	28	7
14	33	50829	86119	52324	85218	53804	84292	55266	83340	56713	82363	27	7
14	34	50854	86104	52349	85203	53828	84277	55291	83324	56736	82347	26	7
15	35	50879	86089	52374	85188	53853	84261	55315	83308	56760	82330	25	7
15	36	50904	86074	52399	85173	53877	84245	55339	83292	56784	82314	24	6
15	37	50929	86059	52423	85157	53902	84230	55363	83276	56808	82297	23	6
16	38	50954	86045	52448	85142	53926	84214	55388	83260	56832	82281	22	6
16	39	50979	86030	52473	85127	53951	84198	55412	83244	56856	82264	21	6
17	40	51004	86015	52498	85112	53975	84182	55436	83228	56880	82248	20	5
17	41	51029	86000	52522	85096	54000	84167	55460	83212	56904	82231	19	5
18	42	51054	85985	52547	85081	54024	84151	55484	83195	56928	82214	18	5
18	43	51079	85970	52572	85066	54049	84135	55509	83179	56952	82198	17	5
18	44	51104	85956	52597	85051	54073	84120	55533	83163	56976	82181	16	4
19	45	51129	85941	52621	85035	54097	84104	55557	83147	57000	82165	15	4
19	46	51154	85926	52646	85020	54122	84088	55581	83131	57024	82148	14	4
20	47	51179	85911	52671	85005	54146	84072	55605	83115	57047	82132	13	3
20	48	51204	85896	52696	84989	54171	84057	55630	83098	57071	82115	12	3
20	49	51229	85881	52720	84974	54195	84041	55654	83082	57095	82098	11	3
21	50	51254	85866	52745	84959	54220	84025	55678	83066	57119	82082	10	3
21	51	51279	85851	52770	84943	54244	84009	55702	83050	57143	82065	9	2
22	52	51304	85836	52794	84928	54269	83994	55726	83034	57167	82048	8	2
22	53	51329	85821	52819	84913	54293	83978	55750	83017	57191	82032	7	2
23	54	51354	85806	52844	84897	54317	83962	55775	83001	57215	82015	6	2
23	55	51379	85792	52869	84882	54342	83946	55799	82985	57238	81999	5	1
23	56	51404	85777	52893	84866	54366	83930	55823	82969	57262	81982	4	1
24	57	51429	85762	52918	84851	54391	83915	55847	82953	57286	81965	3	1
24	58	51454	85747	52943	84836	54415	83899	55871	82936	57310	81949	2	1
25	59	51479	85732	52967	84820	54440	83883	55895	82920	57334	81932	1	0
25	60	51504	85717	52992	84805	54464	83867	55919	82904	57358	81915	0	0
		N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	M.	
		59°		58°		57°		56°		55°			

TABLE 41.

Natural Sines and Cosines.

Prop. parts		35°		36°		37°		38°		39°			Prop. parts
23	M.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.		18
0	0	57358	81915	58779	80902	60182	79864	61566	78801	62932	77715	60	18
0	1	57381	81899	58802	80885	60205	79846	61589	78783	62955	77696	59	18
1	2	57405	81882	58826	80867	60228	79829	61612	78765	62977	77678	58	17
1	3	57429	81865	58849	80850	60251	79811	61635	78747	63000	77660	57	17
2	4	57453	81848	58873	80833	60274	79793	61658	78729	63022	77641	56	17
2	5	57477	81832	58896	80816	60298	79776	61681	78711	63045	77623	55	17
2	6	57501	81815	58920	80799	60321	79758	61704	78694	63068	77605	54	16
3	7	57524	81798	58943	80782	60344	79741	61726	78676	63090	77586	53	16
3	8	57548	81782	58967	80765	60367	79723	61749	78658	63113	77568	52	16
3	9	57572	81765	58990	80748	60390	79706	61772	78640	63135	77550	51	15
4	10	57596	81748	59014	80730	60414	79688	61795	78622	63158	77531	50	15
4	11	57619	81731	59037	80713	60437	79671	61818	78604	63180	77513	49	15
5	12	57643	81714	59061	80696	60460	79653	61841	78586	63203	77494	48	14
5	13	57667	81698	59084	80679	60483	79635	61864	78568	63225	77476	47	14
5	14	57691	81681	59108	80662	60506	79618	61887	78550	63248	77458	46	14
6	15	57715	81664	59131	80644	60529	79600	61909	78532	63271	77439	45	14
6	16	57738	81647	59154	80627	60553	79583	61932	78514	63293	77421	44	13
7	17	57762	81631	59178	80610	60576	79565	61955	78496	63316	77402	43	13
7	18	57786	81614	59201	80593	60599	79547	61978	78478	63338	77384	42	13
7	19	57810	81597	59225	80576	60622	79530	62001	78460	63361	77366	41	12
8	20	57833	81580	59248	80558	60645	79512	62024	78442	63383	77347	40	12
8	21	57857	81563	59272	80541	60668	79494	62046	78424	63406	77329	39	12
8	22	57881	81546	59295	80524	60691	79477	62069	78405	63428	77310	38	11
9	23	57904	81530	59318	80507	60714	79459	62092	78387	63451	77292	37	11
9	24	57928	81513	59342	80489	60738	79441	62115	78369	63473	77273	36	11
10	25	57952	81496	59365	80472	60761	79424	62138	78351	63496	77255	35	11
10	26	57976	81479	59389	80455	60784	79406	62160	78333	63518	77236	34	10
10	27	57999	81462	59412	80438	60807	79388	62183	78315	63540	77218	33	10
11	28	58023	81445	59436	80420	60830	79371	62206	78297	63563	77199	32	10
11	29	58047	81428	59459	80403	60853	79353	62229	78279	63585	77181	31	9
12	30	58070	81412	59482	80386	60876	79335	62251	78261	63608	77162	30	9
12	31	58094	81395	59506	80368	60899	79318	62274	78243	63630	77144	29	9
12	32	58118	81378	59529	80351	60922	79300	62297	78225	63653	77125	28	8
13	33	58141	81361	59552	80334	60945	79282	62320	78206	63675	77107	27	8
13	34	58165	81344	59576	80316	60968	79264	62342	78188	63698	77088	26	8
13	35	58189	81327	59599	80299	60991	79247	62365	78170	63720	77070	25	8
14	36	58212	81310	59622	80282	61015	79229	62388	78152	63742	77051	24	7
14	37	58236	81293	59646	80264	61038	79211	62411	78134	63765	77033	23	7
15	38	58260	81276	59669	80247	61061	79193	62433	78116	63787	77014	22	7
15	39	58283	81259	59693	80230	61084	79176	62456	78098	63810	76996	21	6
15	40	58307	81242	59716	80212	61107	79158	62479	78079	63832	76977	20	6
16	41	58330	81225	59739	80195	61130	79140	62502	78061	63854	76959	19	6
16	42	58354	81208	59763	80178	61153	79122	62524	78043	63877	76940	18	5
16	43	58378	81191	59786	80160	61176	79105	62547	78025	63899	76921	17	5
17	44	58401	81174	59809	80143	61199	79087	62570	78007	63922	76903	16	5
17	45	58425	81157	59832	80125	61222	79069	62592	77988	63944	76884	15	5
18	46	58449	81140	59856	80108	61245	79051	62615	77970	63966	76866	14	4
18	47	58472	81123	59879	80091	61268	79033	62638	77952	63989	76847	13	4
18	48	58496	81106	59902	80073	61291	79016	62660	77934	64011	76828	12	4
19	49	58519	81089	59926	80056	61314	78998	62683	77916	64033	76810	11	3
19	50	58543	81072	59949	80038	61337	78980	62706	77897	64056	76791	10	3
20	51	58567	81055	59972	80021	61360	78962	62728	77879	64078	76772	9	3
20	52	58590	81038	59995	80003	61383	78944	62751	77861	64100	76754	8	2
20	53	58614	81021	60019	79986	61406	78926	62774	77843	64123	76735	7	2
21	54	58637	81004	60042	79968	61429	78908	62796	77824	64145	76717	6	2
21	55	58661	80987	60065	79951	61451	78891	62819	77806	64167	76698	5	2
21	56	58684	80970	60089	79934	61474	78873	62842	77788	64190	76679	4	1
22	57	58708	80953	60112	79916	61497	78855	62864	77769	64212	76661	3	1
22	58	58731	80936	60135	79899	61520	78837	62887	77751	64234	76642	2	1
23	59	58755	80919	60158	79881	61543	78819	62909	77733	64256	76623	1	0
23	60	58779	80902	60182	79864	61566	78801	62932	77715	64279	76604	0.	0
		N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	M.	
		54°		53°		52°		51°		50°			

TABLE 41.

Natural Sines and Cosines.

Prop. parts 22		40°		41°		42°		43°		44°			Prop. parts 19
	M.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.		
0	0	64279	76604	65606	75471	66913	74314	68200	73135	69466	71934	60	19
0	1	64301	76586	65628	75452	66935	74295	68221	73116	69487	71914	59	19
1	2	64323	76567	65650	75433	66956	74276	68242	73096	69508	71894	58	18
1	3	64346	76548	65672	75414	66978	74256	68264	73076	69529	71873	57	18
1	4	64368	76530	65694	75395	66999	74237	68285	73056	69549	71853	56	18
2	5	64390	76511	65716	75375	67021	74217	68306	73036	69570	71833	55	17
2	6	64412	76492	65738	75356	67043	74198	68327	73016	69591	71813	54	17
3	7	64435	76473	65759	75337	67064	74178	68349	72996	69612	71792	53	17
3	8	64457	76455	65781	75318	67086	74159	68370	72976	69633	71772	52	16
3	9	64479	76436	65803	75299	67107	74139	68391	72957	69654	71752	51	16
4	10	64501	76417	65825	75280	67129	74120	68412	72937	69675	71732	50	16
4	11	64524	76398	65847	75261	67151	74100	68434	72917	69696	71711	49	16
4	12	64546	76380	65869	75241	67172	74080	68455	72897	69717	71691	48	15
5	13	64568	76361	65891	75222	67194	74061	68476	72877	69737	71671	47	15
5	14	64590	76342	65913	75203	67215	74041	68497	72857	69758	71650	46	15
6	15	64612	76323	65935	75184	67237	74022	68518	72837	69779	71630	45	14
6	16	64635	76304	65956	75165	67258	74002	68539	72817	69800	71610	44	14
6	17	64657	76286	65978	75146	67280	73983	68561	72797	69821	71590	43	14
7	18	64679	76267	66000	75126	67301	73963	68582	72777	69842	71569	42	13
7	19	64701	76248	66022	75107	67323	73944	68603	72757	69862	71549	41	13
7	20	64723	76229	66044	75088	67344	73924	68624	72737	69883	71529	40	13
8	21	64746	76210	66066	75069	67366	73904	68645	72717	69904	71508	39	12
8	22	64768	76192	66088	75050	67387	73885	68666	72697	69925	71488	38	12
8	23	64790	76173	66109	75030	67409	73865	68688	72677	69946	71468	37	12
9	24	64812	76154	66131	75011	67430	73846	68709	72657	69966	71447	36	11
9	25	64834	76135	66153	74992	67452	73826	68730	72637	69987	71427	35	11
10	26	64856	76116	66175	74973	67473	73806	68751	72617	70008	71407	34	11
10	27	64878	76097	66197	74953	67495	73787	68772	72597	70029	71386	33	10
10	28	64901	76078	66218	74934	67516	73767	68793	72577	70049	71366	32	10
11	29	64923	76059	66240	74915	67538	73747	68814	72557	70070	71345	31	10
11	30	64945	76041	66262	74896	67559	73728	68835	72537	70091	71325	30	10
11	31	64967	76022	66284	74876	67580	73708	68857	72517	70112	71305	29	9
12	32	64989	76003	66306	74857	67602	73688	68878	72497	70132	71284	28	9
12	33	65011	75984	66327	74838	67623	73669	68899	72477	70153	71264	27	9
12	34	65033	75965	66349	74818	67645	73649	68920	72457	70174	71243	26	8
13	35	65055	75946	66371	74799	67666	73629	68941	72437	70195	71223	25	8
13	36	65077	75927	66393	74780	67688	73610	68962	72417	70215	71203	24	8
14	37	65100	75908	66414	74760	67709	73590	68983	72397	70236	71182	23	7
14	38	65122	75889	66436	74741	67730	73570	69004	72377	70257	71162	22	7
14	39	65144	75870	66458	74722	67752	73551	69025	72357	70277	71141	21	7
15	40	65166	75851	66480	74703	67773	73531	69046	72337	70298	71121	20	6
15	41	65188	75832	66501	74683	67795	73511	69067	72317	70319	71100	19	6
15	42	65210	75813	66523	74664	67816	73491	69088	72297	70339	71080	18	6
16	43	65232	75794	66545	74644	67837	73472	69109	72277	70360	71059	17	5
16	44	65254	75775	66566	74625	67859	73452	69130	72257	70381	71039	16	5
17	45	65276	75756	66588	74606	67880	73432	69151	72236	70401	71019	15	5
17	46	65298	75738	66610	74586	67901	73413	69172	72216	70422	70998	14	4
17	47	65320	75719	66632	74567	67923	73393	69193	72196	70443	70978	13	4
18	48	65342	75700	66653	74548	67944	73373	69214	72176	70463	70957	12	4
18	49	65364	75680	66675	74528	67965	73353	69235	72156	70484	70937	11	3
18	50	65386	75661	66697	74509	67987	73333	69256	72136	70505	70916	10	3
19	51	65408	75642	66718	74489	68008	73314	69277	72116	70525	70896	9	3
19	52	65430	75623	66740	74470	68029	73294	69298	72095	70546	70875	8	3
19	53	65452	75604	66762	74451	68051	73274	69319	72075	70567	70855	7	2
20	54	65474	75585	66783	74431	68072	73254	69340	72055	70587	70834	6	2
20	55	65496	75566	66805	74412	68093	73234	69361	72035	70608	70813	5	2
21	56	65518	75547	66827	74392	68115	73215	69382	72015	70628	70793	4	1
21	57	65540	75528	66848	74373	68136	73195	69403	71995	70649	70772	3	1
21	58	65562	75509	66870	74353	68157	73175	69424	71974	70670	70752	2	1
22	59	65584	75490	66891	74334	68179	73155	69445	71954	70690	70731	1	0
22	60	65606	75471	66913	74314	68200	73135	69466	71934	70711	70711	0	0
		N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	M.	
		49°		48°		47°		46°		45°			

TABLE 42.

Logarithms of Numbers.

No. 1——100. Log. 0.00000——2.00000.

No.	Log.	No.	Log.	No.	Log.	No.	Log.	No.	Log.
1	0.00000	21	1.32222	41	1.61278	61	1.78533	81	1.90849
2	0.30103	22	1.34242	42	1.62325	62	1.79239	82	1.91381
3	0.47712	23	1.36173	43	1.63347	63	1.79934	83	1.91908
4	0.60206	24	1.38021	44	1.64345	64	1.80618	84	1.92428
5	0.69897	25	1.39794	45	1.65321	65	1.81291	85	1.92942
6	0.77815	26	1.41497	46	1.66276	66	1.81954	86	1.93450
7	0.84510	27	1.43136	47	1.67210	67	1.82607	87	1.93952
8	0.90309	28	1.44716	48	1.68124	68	1.83251	88	1.94448
9	0.95424	29	1.46240	49	1.69020	69	1.83885	89	1.94939
10	1.00000	30	1.47712	50	1.69897	70	1.84510	90	1.95424
11	1.04139	31	1.49136	51	1.70757	71	1.85126	91	1.95904
12	1.07918	32	1.50515	52	1.71600	72	1.85733	92	1.96379
13	1.11394	33	1.51851	53	1.72428	73	1.86332	93	1.96848
14	1.14613	34	1.53148	54	1.73239	74	1.86923	94	1.97313
15	1.17609	35	1.54407	55	1.74036	75	1.87506	95	1.97772
16	1.20412	36	1.55630	56	1.74819	76	1.88081	96	1.98227
17	1.23045	37	1.56820	57	1.75587	77	1.88649	97	1.98677
18	1.25527	38	1.57978	58	1.76343	78	1.89209	98	1.99123
19	1.27875	39	1.59106	59	1.77085	79	1.89763	99	1.99564
20	1.30103	40	1.60206	60	1.77815	80	1.90309	100	2.00000

TABLE 42.

Logarithms of Numbers.

No. 100——1600. Log. 00000——20412.

No.	0	1	2	3	4	5	6	7	8	9
100	00000	00043	00087	00130	00173	00217	00260	00303	00346	00389
101	00432	00475	00518	00561	00604	00647	00689	00732	00775	00817
102	00860	00903	00945	00988	01030	01072	01115	01157	01199	01242
103	01284	01326	01368	01410	01452	01494	01536	01578	01620	01662
104	01703	01745	01787	01828	01870	01912	01953	01995	02036	02078
105	02119	02160	02202	02243	02284	02325	02366	02407	02449	02490
106	02531	02572	02612	02653	02694	02735	02776	02816	02857	02898
107	02938	02979	03019	03060	03100	03141	03181	03222	03262	03302
108	03342	03383	03423	03463	03503	03543	03583	03623	03663	03703
109	03743	03782	03822	03862	03902	03941	03981	04021	04060	04100
110	04139	04179	04218	04258	04297	04336	04376	04415	04454	04493
111	04532	04571	04610	04650	04689	04727	04766	04805	04844	04883
112	04922	04961	04999	05038	05077	05115	05154	05192	05231	05269
113	05308	05346	05385	05423	05461	05500	05538	05576	05614	05652
114	05690	05729	05767	05805	05843	05881	05918	05956	05994	06032
115	06070	06108	06145	06183	06221	06258	06296	06333	06371	06408
116	06446	06483	06521	06558	06595	06633	06670	06707	06744	06781
117	06819	06856	06893	06930	06967	07004	07041	07078	07115	07151
118	07188	07225	07262	07298	07335	07372	07408	07445	07482	07518
119	07555	07591	07628	07664	07700	07737	07773	07809	07846	07882
120	07918	07954	07990	08027	08063	08099	08135	08171	08207	08243
121	08279	08314	08350	08386	08422	08458	08493	08529	08565	08600
122	08636	08672	08707	08743	08778	08814	08849	08884	08920	08955
123	08991	09026	09061	09096	09132	09167	09202	09237	09272	09307
124	09342	09377	09412	09447	09482	09517	09552	09587	09621	09656
125	09691	09726	09760	09795	09830	09864	09899	09934	09968	10003
126	10037	10072	10106	10140	10175	10209	10243	10278	10312	10346
127	10380	10415	10449	10483	10517	10551	10585	10619	10653	10687
128	10721	10755	10789	10823	10857	10890	10924	10958	10992	11025
129	11059	11093	11126	11160	11193	11227	11261	11294	11327	11361
130	11394	11428	11461	11494	11528	11561	11594	11628	11661	11694
131	11727	11760	11793	11826	11860	11893	11926	11959	11992	12024
132	12057	12090	12123	12156	12189	12222	12254	12287	12320	12352
133	12385	12418	12450	12483	12516	12548	12581	12613	12646	12678
134	12710	12743	12775	12808	12840	12872	12905	12937	12969	13001
135	13033	13066	13098	13130	13162	13194	13226	13258	13290	13322
136	13354	13386	13418	13450	13481	13513	13545	13577	13609	13640
137	13672	13704	13735	13767	13799	13830	13862	13893	13925	13956
138	13988	14019	14051	14082	14114	14145	14176	14208	14239	14270
139	14301	14333	14364	14395	14426	14457	14489	14520	14551	14582
140	14613	14644	14675	14706	14737	14768	14799	14829	14860	14891
141	14922	14953	14983	15014	15045	15076	15106	15137	15168	15198
142	15229	15259	15290	15320	15351	15381	15412	15442	15473	15503
143	15534	15564	15594	15625	15655	15685	15715	15746	15776	15806
144	15836	15866	15897	15927	15957	15987	16017	16047	16077	16107
145	16137	16167	16197	16227	16256	16286	16316	16346	16376	16406
146	16435	16465	16495	16524	16554	16584	16613	16643	16673	16702
147	16732	16761	16791	16820	16850	16879	16909	16938	16967	16997
148	17026	17056	17085	17114	17143	17173	17202	17231	17260	17289
149	17319	17348	17377	17406	17435	17464	17493	17522	17551	17580
150	17609	17638	17667	17696	17725	17754	17782	17811	17840	17869
151	17898	17926	17955	17984	18013	18041	18070	18099	18127	18156
152	18184	18213	18241	18270	18298	18327	18355	18384	18412	18441
153	18469	18498	18526	18554	18583	18611	18639	18667	18696	18724
154	18752	18780	18808	18837	18865	18893	18921	18949	18977	19005
155	19033	19061	19089	19117	19145	19173	19201	19229	19257	19285
156	19312	19340	19368	19396	19424	19451	19479	19507	19535	19562
157	19590	19618	19645	19673	19700	19728	19756	19783	19811	19838
158	19866	19893	19921	19948	19976	20003	20030	20058	20085	20112
159	20140	20167	20194	20222	20249	20276	20303	20330	20358	20385
No.	0	1	2	3	4	5	6	7	8	9

	43	42
1	4	4
2	9	8
3	13	13
4	17	17
5	22	21
6	26	25
7	30	29
8	34	34
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	41	40
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	39	38
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	37	36
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8	30	29
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	35	34
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	33	32
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3	10	10
4	13	13
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7	23	22
8	26	26
9	30	29

TABLE 42.

Logarithms of Numbers.

No. 1600——2200. Log. 20412——34242.

No.	0	1	2	3	4	5	6	7	8	9
160	20412	20439	20466	20493	20520	20548	20575	20602	20629	20656
161	20683	20710	20737	20763	20790	20817	20844	20871	20898	20925
162	20952	20978	21005	21032	21059	21085	21112	21139	21165	21192
163	21219	21245	21272	21299	21325	21352	21378	21405	21431	21458
164	21484	21511	21537	21564	21590	21617	21643	21669	21696	21722
165	21748	21775	21801	21827	21854	21880	21906	21932	21958	21985
166	22011	22037	22063	22089	22115	22141	22167	22194	22220	22246
167	22272	22298	22324	22350	22376	22401	22427	22453	22479	22505
168	22531	22557	22583	22608	22634	22660	22686	22712	22737	22763
169	22789	22814	22840	22866	22891	22917	22943	22968	22994	23019
170	23045	23070	23096	23121	23147	23172	23198	23223	23249	23274
171	23300	23325	23350	23376	23401	23426	23452	23477	23502	23528
172	23553	23578	23603	23629	23654	23679	23704	23729	23754	23779
173	23805	23830	23855	23880	23905	23930	23955	23980	24005	24030
174	24055	24080	24105	24130	24155	24180	24204	24229	24254	24279
175	24304	24329	24353	24378	24403	24428	24452	24477	24502	24527
176	24551	24576	24601	24625	24650	24674	24699	24724	24748	24773
177	24797	24822	24846	24871	24895	24920	24944	24969	24993	25018
178	25042	25066	25091	25115	25139	25164	25188	25212	25237	25261
179	25285	25310	25334	25358	25382	25406	25431	25455	25479	25503
180	25527	25551	25575	25600	25624	25648	25672	25696	25720	25744
181	25768	25792	25816	25840	25864	25888	25912	25935	25959	25983
182	26007	26031	26055	26079	26102	26126	26150	26174	26198	26221
183	26245	26269	26293	26316	26340	26364	26387	26411	26435	26458
184	26482	26505	26529	26553	26576	26600	26623	26647	26670	26694
185	26717	26741	26764	26788	26811	26834	26858	26881	26905	26928
186	26951	26975	26998	27021	27045	27068	27091	27114	27138	27161
187	27184	27207	27231	27254	27277	27300	27323	27346	27370	27393
188	27416	27439	27462	27485	27508	27531	27554	27577	27600	27623
189	27646	27669	27692	27715	27738	27761	27784	27807	27830	27852
190	27875	27898	27921	27944	27967	27989	28012	28035	28058	28081
191	28103	28126	28149	28171	28194	28217	28240	28262	28285	28307
192	28330	28353	28375	28398	28421	28443	28466	28488	28511	28533
193	28556	28578	28601	28623	28646	28668	28691	28713	28735	28758
194	28780	28803	28825	28847	28870	28892	28914	28937	28959	28981
195	29003	29026	29048	29070	29092	29115	29137	29159	29181	29203
196	29226	29248	29270	29292	29314	29336	29358	29380	29403	29425
197	29447	29469	29491	29513	29535	29557	29579	29601	29623	29645
198	29667	29688	29710	29732	29754	29776	29798	29820	29842	29863
199	29885	29907	29929	29951	29973	29994	30016	30038	30060	30081
200	30103	30125	30146	30168	30190	30211	30233	30255	30276	30298
201	30320	30341	30363	30384	30406	30428	30449	30471	30492	30514
202	30535	30557	30578	30600	30621	30643	30664	30685	30707	30728
203	30750	30771	30792	30814	30835	30856	30878	30899	30920	30942
204	30963	30984	31006	31027	31048	31069	31091	31112	31133	31154
205	31175	31197	31218	31239	31260	31281	31302	31323	31345	31366
206	31387	31408	31429	31450	31471	31492	31513	31534	31555	31576
207	31597	31618	31639	31660	31681	31702	31723	31744	31765	31785
208	31806	31827	31848	31869	31890	31911	31931	31952	31973	31994
209	32015	32035	32056	32077	32098	32118	32139	32160	32181	32201
210	32222	32243	32263	32284	32305	32325	32346	32366	32387	32408
211	32428	32449	32469	32490	32510	32531	32552	32572	32593	32613
212	32634	32654	32675	32695	32715	32736	32756	32777	32797	32818
213	32838	32858	32879	32899	32919	32940	32960	32980	33001	33021
214	33041	33062	33082	33102	33122	33143	33163	33183	33203	33224
215	33244	33264	33284	33304	33325	33345	33365	33385	33405	33425
216	33445	33465	33486	33506	33526	33546	33566	33586	33606	33626
217	33646	33666	33686	33706	33726	33746	33766	33786	33806	33826
218	33846	33866	33885	33905	33925	33945	33965	33985	34005	34025
219	34044	34064	34084	34104	34124	34143	34163	34183	34203	34223
No.	0	1	2	3	4	5	6	7	8	9

	31	30
1	3	3
2	6	6
3	9	9
4	12	12
5	16	15
6	19	18
7	22	21
8	25	24
9	28	27
	29	**28**
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7	20	20
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9	26	25
	27	**26**
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	23	**22**
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9	21	20
	21	**20**
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9	19	18

TABLE 42.

Logarithms of Numbers.

No. 2200——2800. Log. 34242——44716.

No.	0	1	2	3	4	5	6	7	8	9
220	34242	34262	34282	34301	34321	34341	34361	34380	34400	34420
221	34439	34459	34479	34498	34518	34537	34557	34577	34596	34616
222	34635	34655	34674	34694	34713	34733	34753	34772	34792	34811
223	34830	34850	34869	34889	34908	34928	34947	34967	34986	35005
224	35025	35044	35064	35083	35102	35122	35141	35160	35180	35199
225	35218	35238	35257	35276	35295	35315	35334	35353	35372	35392
226	35411	35430	35449	35468	35488	35507	35526	35545	35564	35583
227	35603	35622	35641	35660	35679	35698	35717	35736	35755	35774
228	35793	35813	35832	35851	35870	35889	35908	35927	35946	35965
229	35984	36003	36021	36040	36059	36078	36097	36116	36135	36154
230	36173	36192	36211	36229	36248	36267	36286	36305	36324	36342
231	36361	36380	36399	36418	36436	36455	36474	36493	36511	36530
232	36549	36568	36586	36605	36624	36642	36661	36680	36698	36717
233	36736	36754	36773	36791	36810	36829	36847	36866	36884	36903
234	36922	36940	36959	36977	36996	37014	37033	37051	37070	37088
235	37107	37125	37144	37162	37181	37199	37218	37236	37254	37273
236	37291	37310	37328	37346	37365	37383	37401	37420	37438	37457
237	37475	37493	37511	37530	37548	37566	37585	37603	37621	37639
238	37658	37676	37694	37712	37731	37749	37767	37785	37803	37822
239	37840	37858	37876	37894	37912	37931	37949	37967	37985	38003
240	38021	38039	38057	38075	38093	38112	38130	38148	38166	38184
241	38202	38220	38238	38256	38274	38292	38310	38328	38346	38364
242	38382	38399	38417	38435	38453	38471	38489	38507	38525	38543
243	38561	38578	38596	38614	38632	38650	38668	38686	38703	38721
244	38739	38757	38775	38792	38810	38828	38846	38863	38881	38899
245	38917	38934	38952	38970	38987	39005	39023	39041	39058	39076
246	39094	39111	39129	39146	39164	39182	39199	39217	39235	39252
247	39270	39287	39305	39322	39340	39358	39375	39393	39410	39428
248	39445	39463	39480	39498	39515	39533	39550	39568	39585	39602
249	39620	39637	39655	39672	39690	39707	39724	39742	39759	39777
250	39794	39811	39829	39846	39863	39881	39898	39915	39933	39950
251	39967	39985	40002	40019	40037	40054	40071	40088	40106	40123
252	40140	40157	40175	40192	40209	40226	40243	40261	40278	40295
253	40312	40329	40346	40364	40381	40398	40415	40432	40449	40466
254	40483	40500	40518	40535	40552	40569	40586	40603	40620	40637
255	40654	40671	40688	40705	40722	40739	40756	40773	40790	40807
256	40824	40841	40858	40875	40892	40909	40926	40943	40960	40976
257	40993	41010	41027	41044	41061	41078	41095	41111	41128	41145
258	41162	41179	41196	41212	41229	41246	41263	41280	41296	41313
259	41330	41347	41363	41380	41397	41414	41430	41447	41464	41481
260	41497	41514	41531	41547	41564	41581	41597	41614	41631	41647
261	41664	41681	41697	41714	41731	41747	41764	41780	41797	41814
262	41830	41847	41863	41880	41896	41913	41929	41946	41963	41979
263	41996	42012	42029	42045	42062	42078	42095	42111	42127	42144
264	42160	42177	42193	42210	42226	42243	42259	42275	42292	42308
265	42325	42341	42357	42374	42390	42406	42423	42439	42455	42472
266	42488	42504	42521	42537	42553	42570	42586	42602	42619	42635
267	42651	42667	42684	42700	42716	42732	42749	42765	42781	42797
268	42813	42830	42846	42862	42878	42894	42911	42927	42943	42959
269	42975	42991	43008	43024	43040	43056	43072	43088	43104	43120
270	43136	43152	43169	43185	43201	43217	43233	43249	43265	43281
271	43297	43313	43329	43345	43361	43377	43393	43409	43425	43441
272	43457	43473	43489	43505	43521	43537	43553	43569	43584	43600
273	43616	43632	43648	43664	43680	43696	43712	43727	43743	43759
274	43775	43791	43807	43823	43838	43854	43870	43886	43902	43917
275	43933	43949	43965	43981	43996	44012	44028	44044	44059	44075
276	44091	44107	44122	44138	44154	44170	44185	44201	44217	44232
277	44248	44264	44279	44295	44311	44326	44342	44358	44373	44389
278	44404	44420	44436	44451	44467	44483	44498	44514	44529	44545
279	44560	44576	44592	44607	44623	44638	44654	44669	44685	44700
No.	0	1	2	3	4	5	6	7	8	9

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TABLE 42.

Logarithms of Numbers.

No. 2800——3400. Log. 44716——53148.

No.	0	1	2	3	4	5	6	7	8	9
280	44716	44731	44747	44762	44778	44793	44809	44824	44840	44855
281	44871	44886	44902	44917	44932	44948	44963	44979	44994	45010
282	45025	45040	45056	45071	45086	45102	45117	45133	45148	45163
283	45179	45194	45209	45225	45240	45255	45271	45286	45301	45317
284	45332	45347	45362	45378	45393	45408	45423	45439	45454	45469
285	45484	45500	45515	45530	45545	45561	45576	45591	45606	45621
286	45637	45652	45667	45682	45697	45712	45728	45743	45758	45773
287	45788	45803	45818	45834	45849	45864	45879	45894	45909	45924
288	45939	45954	45969	45984	46000	46015	46030	46045	46060	46075
289	46090	46105	46120	46135	46150	46165	46180	46195	46210	46225
290	46240	46255	46270	46285	46300	46315	46330	46345	46359	46374
291	46389	46404	46419	46434	46449	46464	46479	46494	46509	46523
292	46538	46553	46568	46583	46598	46613	46627	46642	46657	46672
293	46687	46702	46716	46731	46746	46761	46776	46790	46805	46820
294	46835	46850	46864	46879	46894	46909	46923	46938	46953	46967
295	46982	46997	47012	47026	47041	47056	47070	47085	47100	47114
296	47129	47144	47159	47173	47188	47202	47217	47232	47246	47261
297	47276	47290	47305	47319	47334	47349	47363	47378	47392	47407
298	47422	47436	47451	47465	47480	47494	47509	47524	47538	47553
299	47567	47582	47596	47611	47625	47640	47654	47669	47683	47698
300	47712	47727	47741	47756	47770	47784	47799	47813	47828	47842
301	47857	47871	47885	47900	47914	47929	47943	47958	47972	47986
302	48001	48015	48029	48044	48058	48073	48087	48101	48116	48130
303	48144	48159	48173	48187	48202	48216	48230	48244	48259	48273
304	48287	48302	48316	48330	48344	48359	48373	48387	48401	48416
305	48430	48444	48458	48473	48487	48501	48515	48530	48544	48558
306	48572	48586	48601	48615	48629	48643	48657	48671	48686	48700
307	48714	48728	48742	48756	48770	48785	48799	48813	48827	48841
308	48855	48869	48883	48897	48911	48926	48940	48954	48968	48982
309	48996	49010	49024	49038	49052	49066	49080	49094	49108	49122
310	49136	49150	49164	49178	49192	49206	49220	49234	49248	49262
311	49276	49290	49304	49318	49332	49346	49360	49374	49388	49402
312	49415	49429	49443	49457	49471	49485	49499	49513	49527	49541
313	49554	49568	49582	49596	49610	49624	49638	49651	49665	49679
314	49693	49707	49721	49734	49748	49762	49776	49790	49803	49817
315	49831	49845	49859	49872	49886	49900	49914	49927	49941	49955
316	49969	49982	49996	50010	50024	50037	50051	50065	50079	50092
317	50106	50120	50133	50147	50161	50174	50188	50202	50215	50229
318	50243	50256	50270	50284	50297	50311	50325	50338	50352	50365
319	50379	50393	50406	50420	50433	50447	50461	50474	50488	50501
320	50515	50529	50542	50556	50569	50583	50596	50610	50623	50637
321	50651	50664	50678	50691	50705	50718	50732	50745	50759	50772
322	50786	50799	50813	50826	50840	50853	50866	50880	50893	50907
323	50920	50934	50947	50961	50974	50987	51001	51014	51028	51041
324	51055	51068	51081	51095	51108	51121	51135	51148	51162	51175
325	51188	51202	51215	51228	51242	51255	51268	51282	51295	51308
326	51322	51335	51348	51362	51375	51388	51402	51415	51428	51441
327	51455	51468	51481	51495	51508	51521	51534	51548	51561	51574
328	51587	51601	51614	51627	51640	51654	51667	51680	51693	51706
329	51720	51733	51746	51759	51772	51786	51799	51812	51825	51838
330	51851	51865	51878	51891	51904	51917	51930	51943	51957	51970
331	51983	51996	52009	52022	52035	52048	52061	52075	52088	52101
332	52114	52127	52140	52153	52166	52179	52192	52205	52218	52231
333	52244	52257	52270	52284	52297	52310	52323	52336	52349	52362
334	52375	52388	52401	52414	52427	52440	52453	52466	52479	52492
335	52504	52517	52530	52543	52556	52569	52582	52595	52608	52621
336	52634	52647	52660	52673	52686	52699	52711	52724	52737	52750
337	52763	52776	52789	52802	52815	52827	52840	52853	52866	52879
338	52892	52905	52917	52930	52943	52956	52969	52982	52994	53007
339	53020	53033	53046	53058	53071	53084	53097	53110	53122	53135
No.	0	1	2	3	4	5	6	7	8	9

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TABLE 42.

Logarithms of Numbers.

No. 3400—4000. Log. 53148—60206.

No.	0	1	2	3	4	5	6	7	8	9		
340	53148	53161	53173	53186	53199	53212	53224	53237	53250	53263		13
341	53275	53288	53301	53314	53326	53339	53352	53364	53377	53390		
342	53403	53415	53428	53441	53453	53466	53479	53491	53504	53517	1	1
343	53529	53542	53555	53567	53580	53593	53605	53618	53631	53643	2	3
344	53656	53668	53681	53694	53706	53719	53732	53744	53757	53769	3	4
345	53782	53794	53807	53820	53832	53845	53857	53870	53882	53895	4	5
346	53908	53920	53933	53945	53958	53970	53983	53995	54008	54020	5	7
347	54033	54045	54058	54070	54083	54095	54108	54120	54133	54145	6	8
348	54158	54170	54183	54195	54208	54220	54233	54245	54258	54270	7	9
349	54283	54295	54307	54320	54332	54345	54357	54370	54382	54394	8	10
350	54407	54419	54432	54444	54456	54469	54481	54494	54506	54518	9	12
351	54531	54543	54555	54568	54580	54593	54605	54617	54630	54642		
352	54654	54667	54679	54691	54704	54716	54728	54741	54753	54765		
353	54777	54790	54802	54814	54827	54839	54851	54864	54876	54888		
354	54900	54913	54925	54937	54949	54962	54974	54986	54998	55011		
355	55023	55035	55047	55060	55072	55084	55096	55108	55121	55133		
356	55145	55157	55169	55182	55194	55206	55218	55230	55242	55255		12
357	55267	55279	55291	55303	55315	55328	55340	55352	55364	55376		
358	55388	55400	55413	55425	55437	55449	55461	55473	55485	55497	1	1
359	55509	55522	55534	55546	55558	55570	55582	55594	55606	55618	2	2
360	55630	55642	55654	55666	55678	55691	55703	55715	55727	55739	3	4
361	55751	55763	55775	55787	55799	55811	55823	55835	55847	55859	4	5
362	55871	55883	55895	55907	55919	55931	55943	55955	55967	55979	5	6
363	55991	56003	56015	56027	56038	56050	56062	56074	56086	56098	6	7
364	56110	56122	56134	56146	56158	56170	56182	56194	56205	56217	7	8
365	56229	56241	56253	56265	56277	56289	56301	56312	56324	56336	8	10
366	56348	56360	56372	56384	56396	56407	56419	56431	56443	56455	9	11
367	56467	56478	56490	56502	56514	56526	56538	56549	56561	56573		
368	56585	56597	56608	56620	56632	56644	56656	56667	56679	56691		
369	56703	56714	56726	56738	56750	56761	56773	56785	56797	56808		
370	56820	56832	56844	56855	56867	56879	56891	56902	56914	56926		
371	56937	56949	56961	56972	56984	56996	57008	57019	57031	57043		
372	57054	57066	57078	57089	57101	57113	57124	57136	57148	57159		
373	57171	57183	57194	57206	57217	57229	57241	57252	57264	57276		11
374	57287	57299	57310	57322	57334	57345	57357	57368	57380	57392		
375	57403	57415	57426	57438	57449	57461	57473	57484	57496	57507	1	1
376	57519	57530	57542	57553	57565	57576	57588	57600	57611	57623	2	2
377	57634	57646	57657	57669	57680	57692	57703	57715	57726	57738	3	3
378	57749	57761	57772	57784	57795	57807	57818	57830	57841	57852	4	4
379	57864	57875	57887	57898	57910	57921	57933	57944	57955	57967	5	6
380	57978	57990	58001	58013	58024	58035	58047	58058	58070	58081	6	7
381	58092	58104	58115	58127	58138	58149	58161	58172	58184	58195	7	8
382	58206	58218	58229	58240	58252	58263	58274	58286	58297	58309	8	9
383	58320	58331	58343	58354	58365	58377	58388	58399	58410	58422	9	10
384	58433	58444	58456	58467	58478	58490	58501	58512	58524	58535		
385	58546	58557	58569	58580	58591	58602	58614	58625	58636	58647		
386	58659	58670	58681	58692	58704	58715	58726	58737	58749	58760		
387	58771	58782	58794	58805	58816	58827	58838	58850	58861	58872		
388	58883	58894	58906	58917	58928	58939	58950	58961	58973	58984		
389	58995	59006	59017	59028	59040	59051	59062	59073	59084	59095		10
390	59106	59118	59129	59140	59151	59162	59173	59184	59195	59207		
391	59218	59229	59240	59251	59262	59273	59284	59295	59306	59318	1	1
392	59329	59340	59351	59362	59373	59384	59395	59406	59417	59428	2	2
393	59439	59450	59461	59472	59483	59494	59506	59517	59528	59539	3	3
394	59550	59561	59572	59583	59594	59605	59616	59627	59638	59649	4	4
395	59660	59671	59682	59693	59704	59715	59726	59737	59748	59759	5	5
396	59770	59780	59791	59802	59813	59824	59835	59846	59857	59868	6	6
397	59879	59890	59901	59912	59923	59934	59945	59956	59966	59977	7	7
398	59988	59999	60010	60021	60032	60043	60054	60065	60076	60086	8	8
399	60097	60108	60119	60130	60141	60152	60163	60173	60184	60195	9	9
No.	0	1	2	3	4	5	6	7	8	9		

TABLE 42.

Logarithms of Numbers.

No. 4000——4600. Log. 60206——66276.

No.	0	1	2	3	4	5	6	7	8	9
400	60206	60217	60228	60239	60249	60260	60271	60282	60293	60304
401	60314	60325	60336	60347	60358	60369	60379	60390	60401	60412
402	60423	60433	60444	60455	60466	60477	60487	60498	60509	60520
403	60531	60541	60552	60563	60574	60584	60595	60606	60617	60627
404	60638	60649	60660	60670	60681	60692	60703	60713	60724	60735
405	60746	60756	60767	60778	60788	60799	60810	60821	60831	60842
406	60853	60863	60874	60885	60895	60906	60917	60927	60938	60949
407	60959	60970	60981	60991	61002	61013	61023	61034	61045	61055
408	61066	61077	61087	61098	61109	61119	61130	61140	61151	61162
409	61172	61183	61194	61204	61215	61225	61236	61247	61257	61268
410	61278	61289	61300	61310	61321	61331	61342	61352	61363	61374
411	61384	61395	61405	61416	61426	61437	61448	61458	61469	61479
412	61490	61500	61511	61521	61532	61542	61553	61563	61574	61584
413	61595	61606	61616	61627	61637	61648	61658	61669	61679	61690
414	61700	61711	61721	61731	61742	61752	61763	61773	61784	61794
415	61805	61815	61826	61836	61847	61857	61868	61878	61888	61899
416	61909	61920	61930	61941	61951	61962	61972	61982	61993	62003
417	62014	62024	62034	62045	62055	62066	62076	62086	62097	62107
418	62118	62128	62138	62149	62159	62170	62180	62190	62201	62211
419	62221	62232	62242	62252	62263	62273	62284	62294	62304	62315
420	62325	62335	62346	62356	62366	62377	62387	62397	62408	62418
421	62428	62439	62449	62459	62469	62480	62490	62500	62511	62521
422	62531	62542	62552	62562	62572	62583	62593	62603	62613	62624
423	62634	62644	62655	62665	62675	62685	62696	62706	62716	62726
424	62737	62747	62757	62767	62778	62788	62798	62808	62818	62829
425	62839	62849	62859	62870	62880	62890	62900	62910	62921	62931
426	62941	62951	62961	62972	62982	62992	63002	63012	63022	63033
427	63043	63053	63063	63073	63083	63094	63104	63114	63124	63134
428	63144	63155	63165	63175	63185	63195	63205	63215	63225	63236
429	63246	63256	63266	63276	63286	63296	63306	63317	63327	63337
430	63347	63357	63367	63377	63387	63397	63407	63417	63428	63438
431	63448	63458	63468	63478	63488	63498	63508	63518	63528	63538
432	63548	63558	63568	63579	63589	63599	63609	63619	63629	63639
433	63649	63659	63669	63679	63689	63699	63709	63719	63729	63739
434	63749	63759	63769	63779	63789	63799	63809	63819	63829	63839
435	63849	63859	63869	63879	63889	63899	63909	63919	63929	63939
436	63949	63959	63969	63979	63988	63998	64008	64018	64028	64038
437	64048	64058	64068	64078	64088	64098	64108	64118	64128	64137
438	64147	64157	64167	64177	64187	64197	64207	64217	64227	64237
439	64246	64256	64266	64276	64286	64296	64306	64316	64326	64335
440	64345	64355	64365	64375	64385	64395	64404	64414	64424	64434
441	64444	64454	64464	64473	64483	64493	64503	64513	64523	64532
442	64542	64552	64562	64572	64582	64591	64601	64611	64621	64631
443	64640	64650	64660	64670	64680	64689	64699	64709	64719	64729
444	64738	64748	64758	64768	64777	64787	64797	64807	64816	64826
445	64836	64846	64856	64865	64875	64885	64895	64904	64914	64924
446	64933	64943	64953	64963	64972	64982	64992	65002	65011	65021
447	65031	65040	65050	65060	65070	65079	65089	65099	65108	65118
448	65128	65137	65147	65157	65167	65176	65186	65196	65205	65215
449	65225	65234	65244	65254	65263	65273	65283	65292	65302	65312
450	65321	65331	65341	65350	65360	65369	65379	65389	65398	65408
451	65418	65427	65437	65447	65456	65466	65475	65485	65495	65504
452	65514	65523	65533	65543	65552	65562	65571	65581	65591	65600
453	65610	65619	65629	65639	65648	65658	65667	65677	65686	65696
454	65706	65715	65725	65734	65744	65753	65763	65772	65782	65792
455	65801	65811	65820	65830	65839	65849	65858	65868	65877	65887
456	65896	65906	65916	65925	65935	65944	65954	65963	65973	65982
457	65992	66001	66011	66020	66030	66039	66049	66058	66068	66077
458	66087	66096	66106	66115	66124	66134	66143	66153	66162	66172
459	66181	66191	66200	66210	66219	66229	66238	66247	66257	66266
No.	0	1	2	3	4	5	6	7	8	9

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TABLE 42.

Logarithms of Numbers.

No. 4600——5200. Log. 66276——71600.

No.	0	1	2	3	4	5	6	7	8	9
460	66276	66285	66295	66304	66314	66323	66332	66342	66351	66361
461	66370	66380	66389	66398	66408	66417	66427	66436	66445	66455
462	66464	66474	66483	66492	66502	66511	66521	66530	66539	66549
463	66558	66567	66577	66586	66596	66605	66614	66624	66633	66642
464	66652	66661	66671	66680	66689	66699	66708	66717	66727	66736
465	66745	66755	66764	66773	66783	66792	66801	66811	66820	66829
466	66839	66848	66857	66867	66876	66885	66894	66904	66913	66922
467	66932	66941	66950	66960	66969	66978	66987	66997	67006	67015
468	67025	67034	67043	67052	67062	67071	67080	67089	67099	67108
469	67117	67127	67136	67145	67154	67164	67173	67182	67191	67201
470	67210	67219	67228	67237	67247	67256	67265	67274	67284	67293
471	67302	67311	67321	67330	67339	67348	67357	67367	67376	67385
472	67394	67403	67413	67422	67431	67440	67449	67459	67468	67477
473	67486	67495	67504	67514	67523	67532	67541	67550	67560	67569
474	67578	67587	67596	67605	67614	67624	67633	67642	67651	67660
475	67669	67679	67688	67697	67706	67715	67724	67733	67742	67752
476	67761	67770	67779	67788	67797	67806	67815	67825	67834	67843
477	67852	67861	67870	67879	67888	67897	67906	67916	67925	67934
478	67943	67952	67961	67970	67979	67988	67997	68006	68015	68024
479	68034	68043	68052	68061	68070	68079	68088	68097	68106	68115
480	68124	68133	68142	68151	68160	68169	68178	68187	68196	68205
481	68215	68224	68233	68242	68251	68260	68269	68278	68287	68296
482	68305	68314	68323	68332	68341	68350	68359	68368	68377	68386
483	68395	68404	68413	68422	68431	68440	68449	68458	68467	68476
484	68485	68494	68502	68511	68520	68529	68538	68547	68556	68565
485	68574	68583	68592	68601	68610	68619	68628	68637	68646	68655
486	68664	68673	68681	68690	68699	68708	68717	68726	68735	68744
487	68753	68762	68771	68780	68789	68797	68806	68815	68824	68833
488	68842	68851	68860	68869	68878	68886	68895	68904	68913	68922
489	68931	68940	68949	68958	68966	68975	68984	68993	69002	69011
490	69020	69028	69037	69046	69055	69064	69073	69082	69090	69099
491	69108	69117	69126	69135	69144	69152	69161	69170	69179	69188
492	69197	69205	69214	69223	69232	69241	69249	69258	69267	69276
493	69285	69294	69302	69311	69320	69329	69338	69346	69355	69364
494	69373	69381	69390	69399	69408	69417	69425	69434	69443	69452
495	69461	69469	69478	69487	69496	69504	69513	69522	69531	69539
496	69548	69557	69566	69574	69583	69592	69601	69609	69618	69627
497	69636	69644	69653	69662	69671	69679	69688	69697	69705	69714
498	69723	69732	69740	69749	69758	69767	69775	69784	69793	69801
499	69810	69819	69827	69836	69845	69854	69862	69871	69880	69888
500	69897	69906	69914	69923	69932	69940	69949	69958	69966	69975
501	69984	69992	70001	70010	70018	70027	70036	70044	70053	70062
502	70070	70079	70088	70096	70105	70114	70122	70131	70140	70148
503	70157	70165	70174	70183	70191	70200	70209	70217	70226	70234
504	70243	70252	70260	70269	70278	70286	70295	70303	70312	70321
505	70329	70338	70346	70355	70364	70372	70381	70389	70398	70406
506	70415	70424	70432	70441	70449	70458	70467	70475	70484	70492
507	70501	70509	70518	70526	70535	70544	70552	70561	70569	70578
508	70586	70595	70603	70612	70621	70629	70638	70646	70655	70663
509	70672	70680	70689	70697	70706	70714	70723	70731	70740	70749
510	70757	70766	70774	70783	70791	70800	70808	70817	70825	70834
511	70842	70851	70859	70868	70876	70885	70893	70902	70910	70919
512	70927	70935	70944	70952	70961	70969	70978	70986	70995	71003
513	71012	71020	71029	71037	71046	71054	71063	71071	71079	71088
514	71096	71105	71113	71122	71130	71139	71147	71155	71164	71172
515	71181	71189	71198	71206	71214	71223	71231	71240	71248	71257
516	71265	71273	71282	71290	71299	71307	71315	71324	71332	71341
517	71349	71357	71366	71374	71383	71391	71399	71408	71416	71425
518	71433	71441	71450	71458	71466	71475	71483	71492	71500	71508
519	71517	71525	71533	71542	71550	71559	71567	71575	71584	71592
No.	0	1	2	3	4	5	6	7	8	9

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TABLE 42.

Logarithms of Numbers.

No. 5200——5800. Log. 71600——76343.

No.	0	1	2	3	4	5	6	7	8	9
520	71600	71609	71617	71625	71634	71642	71650	71659	71667	71675
521	71684	71692	71700	71709	71717	71725	71734	71742	71750	71759
522	71767	71775	71784	71792	71800	71809	71817	71825	71834	71842
523	71850	71858	71867	71875	71883	71892	71900	71908	71917	71925
524	71933	71941	71950	71958	71966	71975	71983	71991	71999	72008
525	72016	72024	72032	72041	72049	72057	72066	72074	72082	72090
526	72099	72107	72115	72123	72132	72140	72148	72156	72165	72173
527	72181	72189	72198	72206	72214	72222	72230	72239	72247	72255
528	72263	72272	72280	72288	72296	72304	72313	72321	72329	72337
529	72346	72354	72362	72370	72378	72387	72395	72403	72411	72419
530	72428	72436	72444	72452	72460	72469	72477	72485	72493	72501
531	72509	72518	72526	72534	72542	72550	72558	72567	72575	72583
532	72591	72599	72607	72616	72624	72632	72640	72648	72656	72665
533	72673	72681	72689	72697	72705	72713	72722	72730	72738	72746
534	72754	72762	72770	72779	72787	72795	72803	72811	72819	72827
535	72835	72843	72852	72860	72868	72876	72884	72892	72900	72908
536	72916	72925	72933	72941	72949	72957	72965	72973	72981	72989
537	72997	73006	73014	73022	73030	73038	73046	73054	73062	73070
538	73078	73086	73094	73102	73111	73119	73127	73135	73143	73151
539	73159	73167	73175	73183	73191	73199	73207	73215	73223	73231
540	73239	73247	73255	73263	73272	73280	73288	73296	73304	73312
541	73320	73328	73336	73344	73352	73360	73368	73376	73384	73392
542	73400	73408	73416	73424	73432	73440	73448	73456	73464	73472
543	73480	73488	73496	73504	73512	73520	73528	73536	73544	73552
544	73560	73568	73576	73584	73592	73600	73608	73616	73624	73632
545	73640	73648	73656	73664	73672	73679	73687	73695	73703	73711
546	73719	73727	73735	73743	73751	73759	73767	73775	73783	73791
547	73799	73807	73815	73823	73830	73838	73846	73854	73862	73870
548	73878	73886	73894	73902	73910	73918	73926	73933	73941	73949
549	73957	73965	73973	73981	73989	73997	74005	74013	74020	74028
550	74036	74044	74052	74060	74068	74076	74084	74092	74099	74107
551	74115	74123	74131	74139	74147	74155	74162	74170	74178	74186
552	74194	74202	74210	74218	74225	74233	74241	74249	74257	74265
553	74273	74280	74288	74296	74304	74312	74320	74327	74335	74343
554	74351	74359	74367	74374	74382	74390	74398	74406	74414	74421
555	74429	74437	74445	74453	74461	74468	74476	74484	74492	74500
556	74507	74515	74523	74531	74539	74547	74554	74562	74570	74578
557	74586	74593	74601	74609	74617	74624	74632	74640	74648	74656
558	74663	74671	74679	74687	74695	74702	74710	74718	74726	74733
559	74741	74749	74757	74764	74772	74780	74788	74796	74803	74811
560	74819	74827	74834	74842	74850	74858	74865	74873	74881	74889
561	74896	74904	74912	74920	74927	74935	74943	74950	74958	74966
562	74974	74981	74989	74997	75005	75012	75020	75028	75035	75043
563	75051	75059	75066	75074	75082	75089	75097	75105	75113	75120
564	75128	75136	75143	75151	75159	75166	75174	75182	75189	75197
565	75205	75213	75220	75228	75236	75243	75251	75259	75266	75274
566	75282	75289	75297	75305	75312	75320	75328	75335	75343	75351
567	75358	75366	75374	75381	75389	75397	75404	75412	75420	75427
568	75435	75442	75450	75458	75465	75473	75481	75488	75496	75504
569	75511	75519	75526	75534	75542	75549	75557	75565	75572	75580
570	75587	75595	75603	75610	75618	75626	75633	75641	75648	75656
571	75664	75671	75679	75686	75694	75702	75709	75717	75724	75732
572	75740	75747	75755	75762	75770	75778	75785	75793	75800	75808
573	75815	75823	75831	75838	75846	75853	75861	75868	75876	75884
574	75891	75899	75906	75914	75921	75929	75937	75944	75952	75959
575	75967	75974	75982	75989	75997	76005	76012	76020	76027	76035
576	76042	76050	76057	76065	76072	76080	76087	76095	76103	76110
577	76118	76125	76133	76140	76148	76155	76163	76170	76178	76185
578	76193	76200	76208	76215	76223	76230	76238	76245	76253	76260
579	76268	76275	76283	76290	76298	76305	76313	76320	76328	76335
No.	0	1	2	3	4	5	6	7	8	9

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TABLE 42.

Logarithms of Numbers.

No. 5800——6400. Log. 76343——80618.

No.	0	1	2	3	4	5	6	7	8	9		
580	76343	76350	76358	76365	76373	76380	76388	76395	76403	76410		8
581	76418	76425	76433	76440	76448	76455	76462	76470	76477	76485		
582	76492	76500	76507	76515	76522	76530	76537	76545	76552	76559	1	1
583	76567	76574	76582	76589	76597	76604	76612	76619	76626	76634	2	2
584	76641	76649	76656	76664	76671	76678	76686	76693	76701	76708	3	2
585	76716	76723	76730	76738	76745	76753	76760	76768	76775	76782	4	3
586	76790	76797	76805	76812	76819	76827	76834	76842	76849	76856	5	4
587	76864	76871	76879	76886	76893	76901	76908	76916	76923	76930	6	5
588	76938	76945	76953	76960	76967	76975	76982	76989	76997	77004	7	6
589	77012	77019	77026	77034	77041	77048	77056	77063	77070	77078	8	6
590	77085	77093	77100	77107	77115	77122	77129	77137	77144	77151	9	7
591	77159	77166	77173	77181	77188	77195	77203	77210	77217	77225		
592	77232	77240	77247	77254	77262	77269	77276	77283	77291	77298		
593	77305	77313	77320	77327	77335	77342	77349	77357	77364	77371		
594	77379	77386	77393	77401	77408	77415	77422	77430	77437	77444		
595	77452	77459	77466	77474	77481	77488	77495	77503	77510	77517		
596	77525	77532	77539	77546	77554	77561	77568	77576	77583	77590		
597	77597	77605	77612	77619	77627	77634	77641	77648	77656	77663		
598	77670	77677	77685	77692	77699	77706	77714	77721	77728	77735		
599	77743	77750	77757	77764	77772	77779	77786	77793	77801	77808		
600	77815	77822	77830	77837	77844	77851	77859	77866	77873	77880		
601	77887	77895	77902	77909	77916	77924	77931	77938	77945	77952		
602	77960	77967	77974	77981	77988	77996	78003	78010	78017	78025		
603	78032	78039	78046	78053	78061	78068	78075	78082	78089	78097		
604	78104	78111	78118	78125	78132	78140	78147	78154	78161	78168		
605	78176	78183	78190	78197	78204	78211	78219	78226	78233	78240		7
606	78247	78254	78262	78269	78276	78283	78290	78297	78305	78312		
607	78319	78326	78333	78340	78347	78355	78362	78369	78376	78383	1	1
608	78390	78398	78405	78412	78419	78426	78433	78440	78447	78455	2	1
609	78462	78469	78476	78483	78490	78497	78504	78512	78519	78526	3	2
610	78533	78540	78547	78554	78561	78569	78576	78583	78590	78597	4	3
611	78604	78611	78618	78625	78633	78640	78647	78654	78661	78668	5	4
612	78675	78682	78689	78696	78704	78711	78718	78725	78732	78739	6	4
613	78746	78753	78760	78767	78774	78781	78789	78796	78803	78810	7	5
614	78817	78824	78831	78838	78845	78852	78859	78866	78873	78880	8	6
615	78888	78895	78902	78909	78916	78923	78930	78937	78944	78951	9	6
616	78958	78965	78972	78979	78986	78993	79000	79007	79014	79021		
617	79029	79036	79043	79050	79057	79064	79071	79078	79085	79092		
618	79099	79106	79113	79120	79127	79134	79141	79148	79155	79162		
619	79169	79176	79183	79190	79197	79204	79211	79218	79225	79232		
620	79239	79246	79253	79260	79267	79274	79281	79288	79295	79302		
621	79309	79316	79323	79330	79337	79344	79351	79358	79365	79372		
622	79379	79386	79393	79400	79407	79414	79421	79428	79435	79442		
623	79449	79456	79463	79470	79477	79484	79491	79498	79505	79511		
624	79518	79525	79532	79539	79546	79553	79560	79567	79574	79581		
625	79588	79595	79602	79609	79616	79623	79630	79637	79644	79650		
626	79657	79664	79671	79678	79685	79692	79699	79706	79713	79720		
627	79727	79734	79741	79748	79754	79761	79768	79775	79782	79789		
628	79796	79803	79810	79817	79824	79831	79837	79844	79851	79858		
629	79865	79872	79879	79886	79893	79900	79906	79913	79920	79927		6
630	79934	79941	79948	79955	79962	79969	79975	79982	79989	79996		
631	80003	80010	80017	80024	80030	80037	80044	80051	80058	80065	1	1
632	80072	80079	80085	80092	80099	80106	80113	80120	80127	80134	2	1
633	80140	80147	80154	80161	80168	80175	80182	80188	80195	80202	3	2
634	80209	80216	80223	80229	80236	80243	80250	80257	80264	80271	4	2
635	80277	80284	80291	80298	80305	80312	80318	80325	80332	80339	5	3
636	80346	80353	80359	80366	80373	80380	80387	80393	80400	80407	6	4
637	80414	80421	80428	80434	80441	80448	80455	80462	80468	80475	7	4
638	80482	80489	80496	80502	80509	80516	80523	80530	80536	80543	8	5
639	80550	80557	80564	80570	80577	80584	80591	80598	80604	80611	9	5
No.	0	1	2	3	4	5	6	7	8	9		

TABLE 42.

Logarithms of Numbers.

No. 6400——7000. Log. 80618——84510.

No.	0	1	2	3	4	5	6	7	8	9
640	80618	80625	80632	80638	80645	80652	80659	80665	80672	80679
641	80686	80693	80699	80706	80713	80720	80726	80733	80740	80747
642	80754	80760	80767	80774	80781	80787	80794	80801	80808	80814
643	80821	80828	80835	80841	80848	80855	80862	80868	80875	80882
644	80889	80895	80902	80909	80916	80922	80929	80936	80943	80949
645	80956	80963	80969	80976	80983	80990	80996	81003	81010	81017
646	81023	81030	81037	81043	81050	81057	81064	81070	81077	81084
647	81090	81097	81104	81111	81117	81124	81131	81137	81144	81151
648	81158	81164	81171	81178	81184	81191	81198	81204	81211	81218
649	81224	81231	81238	81245	81251	81258	81265	81271	81278	81285
650	81291	81298	81305	81311	81318	81325	81331	81338	81345	81351
651	81358	81365	81371	81378	81385	81391	81398	81405	81411	81418
652	81425	81431	81438	81445	81451	81458	81465	81471	81478	81485
653	81491	81498	81505	81511	81518	81525	81531	81538	81544	81551
654	81558	81564	81571	81578	81584	81591	81598	81604	81611	81617
655	81624	81631	81637	81644	81651	81657	81664	81671	81677	81684
656	81690	81697	81704	81710	81717	81723	81730	81737	81743	81750
657	81757	81763	81770	81776	81783	81790	81796	81803	81809	81816
658	81823	81829	81836	81842	81849	81856	81862	81869	81875	81882
659	81889	81895	81902	81908	81915	81921	81928	81935	81941	81948
660	81954	81961	81968	81974	81981	81987	81994	82000	82007	82014
661	82020	82027	82033	82040	82046	82053	82060	82066	82073	82079
662	82086	82092	82099	82105	82112	82119	82125	82132	82138	82145
663	82151	82158	82164	82171	82178	82184	82191	82197	82204	82210
664	82217	82223	82230	82236	82243	82249	82256	82263	82269	82276
665	82282	82289	82295	82302	82308	82315	82321	82328	82334	82341
666	82347	82354	82360	82367	82373	82380	82387	82393	82400	82406
667	82413	82419	82426	82432	82439	82445	82452	82458	82465	82471
668	82478	82484	82491	82497	82504	82510	82517	82523	82530	82536
669	82543	82549	82556	82562	82569	82575	82582	82588	82595	82601
670	82607	82614	82620	82627	82633	82640	82646	82653	82659	82666
671	82672	82679	82685	82692	82698	82705	82711	82718	82724	82730
672	82737	82743	82750	82756	82763	82769	82776	82782	82789	82795
673	82802	82808	82814	82821	82827	82834	82840	82847	82853	82860
674	82866	82872	82879	82885	82892	82898	82905	82911	82918	82924
675	82930	82937	82943	82950	82956	82963	82969	82975	82982	82988
676	82995	83001	83008	83014	83020	83027	83033	83040	83046	83052
677	83059	83065	83072	83078	83085	83091	83097	83104	83110	83117
678	83123	83129	83136	83142	83149	83155	83161	83168	83174	83181
679	83187	83193	83200	83206	83213	83219	83225	83232	83238	83245
680	83251	83257	83264	83270	83276	83283	83289	83296	83302	83308
681	83315	83321	83327	83334	83340	83347	83353	83359	83366	83372
682	83378	83385	83391	83398	83404	83410	83417	83423	83429	83436
683	83442	83448	83455	83461	83467	83474	83480	83487	83493	83499
684	83506	83512	83518	83525	83531	83537	83544	83550	83556	83563
685	83569	83575	83582	83588	83594	83601	83607	83613	83620	83626
686	83632	83639	83645	83651	83658	83664	83670	83677	83683	83689
687	83696	83702	83708	83715	83721	83727	83734	83740	83746	83753
688	83759	83765	83771	83778	83784	83790	83797	83803	83809	83816
689	83822	83828	83835	83841	83847	83853	83860	83866	83872	83879
690	83885	83891	83897	83904	83910	83916	83923	83929	83935	83942
691	83948	83954	83960	83967	83973	83979	83985	83992	83998	84004
692	84011	84017	84023	84029	84036	84042	84048	84055	84061	84067
693	84073	84080	84086	84092	84098	84105	84111	84117	84123	84130
694	84136	84142	84148	84155	84161	84167	84173	84180	84186	84192
695	84198	84205	84211	84217	84223	84230	84236	84242	84248	84255
696	84261	84267	84273	84280	84286	84292	84298	84305	84311	84317
697	84323	84330	84336	84342	84348	84354	84361	84367	84373	84379
698	84386	84392	84398	84404	84410	84417	84423	84429	84435	84442
699	84448	84454	84460	84466	84473	84479	84485	84491	84497	84504
No.	0	1	2	3	4	5	6	7	8	9

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TABLE 42.

Logarithms of Numbers.

No. 7000——7600. Log. 84510——88081.

No.	0	1	2	3	4	5	6	7	8	9		
700	84510	84516	84522	84528	84535	84541	84547	84553	84559	84566		7
701	84572	84578	84584	84590	84597	84603	84609	84615	84621	84628		
702	84634	84640	84646	84652	84658	84665	84671	84677	84683	84689	1	1
703	84696	84702	84708	84714	84720	84726	84733	84739	84745	84751	2	1
704	84757	84763	84770	84776	84782	84788	84794	84800	84807	84813	3	2
705	84819	84825	84831	84837	84844	84850	84856	84862	84868	84874	4	3
706	84880	84887	84893	84899	84905	84911	84917	84924	84930	84936	5	4
707	84942	84948	84954	84960	84967	84973	84979	84985	84991	84997	6	4
708	85003	85009	85016	85022	85028	85034	85040	85046	85052	85058	7	5
709	85065	85071	85077	85083	85089	85095	85101	85107	85114	85120	8	6
710	85126	85132	85138	85144	85150	85156	85163	85169	85175	85181	9	6
711	85187	85193	85199	85205	85211	85217	85224	85230	85236	85242		
712	85248	85254	85260	85266	85272	85278	85285	85291	85297	85303		
713	85309	85315	85321	85327	85333	85339	85345	85352	85358	85364		
714	85370	85376	85382	85388	85394	85400	85406	85412	85418	85425		
715	85431	85437	85443	85449	85455	85461	85467	85473	85479	85485		
716	85491	85497	85503	85509	85516	85522	85528	85534	85540	85546		
717	85552	85558	85564	85570	85576	85582	85588	85594	85600	85606		
718	85612	85618	85625	85631	85637	85643	85649	85655	85661	85667		
719	85673	85679	85685	85691	85697	85703	85709	85715	85721	85727		
720	85733	85739	85745	85751	85757	85763	85769	85775	85781	85788		
721	85794	85800	85806	85812	85818	85824	85830	85836	85842	85848		
722	85854	85860	85866	85872	85878	85884	85890	85896	85902	85908		
723	85914	85920	85926	85932	85938	85944	85950	85956	85962	85968		
724	85974	85980	85986	85992	85998	86004	86010	86016	86022	86028		6
725	86034	86040	86046	86052	86058	86064	86070	86076	86082	86088		
726	86094	86100	86106	86112	86118	86124	86130	86136	86141	86147	1	1
727	86153	86159	86165	86171	86177	86183	86189	86195	86201	86207	2	1
728	86213	86219	86225	86231	86237	86243	86249	86255	86261	86267	3	2
729	86273	86279	86285	86291	86297	86303	86308	86314	86320	86326	4	2
730	86332	86338	86344	86350	86356	86362	86368	86374	86380	86386	5	3
731	86392	86398	86404	86410	86415	86421	86427	86433	86439	86445	6	4
732	86451	86457	86463	86469	86475	86481	86487	86493	86499	86504	7	4
733	86510	86516	86522	86528	86534	86540	86546	86552	86558	86564	8	5
734	86570	86576	86581	86587	86593	86599	86605	86611	86617	86623	9	5
735	86629	86635	86641	86646	86652	86658	86664	86670	86676	86682		
736	86688	86694	86700	86705	86711	86717	86723	86729	86735	86741		
737	86747	86753	86759	86764	86770	86776	86782	86788	86794	86800		
738	86806	86812	86817	86823	86829	86835	86841	86847	86853	86859		
739	86864	86870	86876	86882	86888	86894	86900	86906	86911	86917		
740	86923	86929	86935	86941	86947	86953	86958	86964	86970	86976		
741	86982	86988	86994	86999	87005	87011	87017	87023	87029	87035		
742	87040	87046	87052	87058	87064	87070	87075	87081	87087	87093		
743	87099	87105	87111	87116	87122	87128	87134	87140	87146	87151		
744	87157	87163	87169	87175	87181	87186	87192	87198	87204	87210		
745	87216	87221	87227	87233	87239	87245	87251	87256	87262	87268		
746	87274	87280	87286	87291	87297	87303	87309	87315	87320	87326		
747	87332	87338	87344	87349	87355	87361	87367	87373	87379	87384		
748	87390	87396	87402	87408	87413	87419	87425	87431	87437	87442		
749	87448	87454	87460	87466	87471	87477	87483	87489	87495	87500		5
750	87506	87512	87518	87523	87529	87535	87541	87547	87552	87558		
751	87564	87570	87576	87581	87587	87593	87599	87604	87610	87616	1	1
752	87622	87628	87633	87639	87645	87651	87656	87662	87668	87674	2	1
753	87679	87685	87691	87697	87703	87708	87714	87720	87726	87731	3	2
754	87737	87743	87749	87754	87760	87766	87772	87777	87783	87789	4	2
755	87795	87800	87806	87812	87818	87823	87829	87835	87841	87846	5	3
756	87852	87858	87864	87869	87875	87881	87887	87892	87898	87904	6	3
757	87910	87915	87921	87927	87933	87938	87944	87950	87955	87961	7	4
758	87967	87973	87978	87984	87990	87996	88001	88007	88013	88018	8	4
759	88024	88030	88036	88041	88047	88053	88058	88064	88070	88076	9	5
No.	0	1	2	3	4	5	6	7	8	9		

TABLE 42.

Logarithms of Numbers.

No. 7600——8200. Log. 88081——91381.

No.	0	1	2	3	4	5	6	7	8	9		
760	88081	88087	88093	88098	88104	88110	88116	88121	88127	88133		6
761	88138	88144	88150	88156	88161	88167	88173	88178	88184	88190		
762	88195	88201	88207	88213	88218	88224	88230	88235	88241	88247	1	1
763	88252	88258	88264	88270	88275	88281	88287	88292	88298	88304	2	1
764	88309	88315	88321	88326	88332	88338	88343	88349	88355	88360	3	2
765	88366	88372	88377	88383	88389	88395	88400	88406	88412	88417	4	2
766	88423	88429	88434	88440	88446	88451	88457	88463	88468	88474	5	3
767	88480	88485	88491	88497	88502	88508	88513	88519	88525	88530	6	4
768	88536	88542	88547	88553	88559	88564	88570	88576	88581	88587	7	4
769	88593	88598	88604	88610	88615	88621	88627	88632	88638	88643	8	5
770	88649	88655	88660	88666	88672	88677	88683	88689	88694	88700	9	5
771	88705	88711	88717	88722	88728	88734	88739	88745	88750	88756		
772	88762	88767	88773	88779	88784	88790	88795	88801	88807	88812		
773	88818	88824	88829	88835	88840	88846	88852	88857	88863	88868		
774	88874	88880	88885	88891	88897	88902	88908	88913	88919	88925		
775	88930	88936	88941	88947	88953	88958	88964	88969	88975	88981		
776	88986	88992	88997	89003	89009	89014	89020	89025	89031	89037		
777	89042	89048	89053	89059	89064	89070	89076	89081	89087	89092		
778	89098	89104	89109	89115	89120	89126	89131	89137	89143	89148		
779	89154	89159	89165	89170	89176	89182	89187	89193	89198	89204		
780	89209	89215	89221	89226	89232	89237	89243	89248	89254	89260		
781	89265	89271	89276	89282	89287	89293	89298	89304	89310	89315		
782	89321	89326	89332	89337	89343	89348	89354	89360	89365	89371		
783	89376	89382	89387	89393	89398	89404	89409	89415	89421	89426		
784	89432	89437	89443	89448	89454	89459	89465	89470	89476	89481		
785	89487	89492	89498	89504	89509	89515	89520	89526	89531	89537		
786	89542	89548	89553	89559	89564	89570	89575	89581	89586	89592		
787	89597	89603	89609	89614	89620	89625	89631	89636	89642	89647		
788	89653	89658	89664	89669	89675	89680	89686	89691	89697	89702		
789	89708	89713	89719	89724	89730	89735	89741	89746	89752	89757		
790	89763	89768	89774	89779	89785	89790	89796	89801	89807	89812		
791	89818	89823	89829	89834	89840	89845	89851	89856	89862	89867		
792	89873	89878	89883	89889	89894	89900	89905	89911	89916	89922		
793	89927	89933	89938	89944	89949	89955	89960	89966	89971	89977		
794	89982	89988	89993	89998	90004	90009	90015	90020	90026	90031		
795	90037	90042	90048	90053	90059	90064	90069	90075	90080	90086		
796	90091	90097	90102	90108	90113	90119	90124	90129	90135	90140		
797	90146	90151	90157	90162	90168	90173	90179	90184	90189	90195		
798	90200	90206	90211	90217	90222	90227	90233	90238	90244	90249		
799	90255	90260	90266	90271	90276	90282	90287	90293	90298	90304		
800	90309	90314	90320	90325	90331	90336	90342	90347	90352	90358		
801	90363	90369	90374	90380	90385	90390	90396	90401	90407	90412		
802	90417	90423	90428	90434	90439	90445	90450	90455	90461	90466		
803	90472	90477	90482	90488	90493	90499	90504	90509	90515	90520		
804	90526	90531	90536	90542	90547	90553	90558	90563	90569	90574		
805	90580	90585	90590	90596	90601	90607	90612	90617	90623	90628		
806	90634	90639	90644	90650	90655	90660	90666	90671	90677	90682		
807	90687	90693	90698	90703	90709	90714	90720	90725	90730	90736		
808	90741	90747	90752	90757	90763	90768	90773	90779	90784	90789		
809	90795	90800	90806	90811	90816	90822	90827	90832	90838	90843		5
810	90849	90854	90859	90865	90870	90875	90881	90886	90891	90897		
811	90902	90907	90913	90918	90924	90929	90934	90940	90945	90950	1	1
812	90956	90961	90966	90972	90977	90982	90988	90993	90998	91004	2	1
813	91009	91014	91020	91025	91030	91036	91041	91046	91052	91057	3	2
814	91062	91068	91073	91078	91084	91089	91094	91100	91105	91110	4	2
815	91116	91121	91126	91132	91137	91142	91148	91153	91158	91164	5	3
816	91169	91174	91180	91185	91190	91196	91201	91206	91212	91217	6	3
817	91222	91228	91233	91238	91243	91249	91254	91259	91265	91270	7	4
818	91275	91281	91286	91291	91297	91302	91307	91312	91318	91323	8	4
819	91328	91334	91339	91344	91350	91355	91360	91365	91371	91376	9	5
No.	0	1	2	3	4	5	6	7	8	9		

TABLE 42.

Logarithms of Numbers.

No. 8200——8800. Log. 91381——94448

No.	0	1	2	3	4	5	6	7	8	9
820	91381	91387	91392	91397	91403	91408	91413	91418	91424	91429
821	91434	91440	91445	91450	91455	91461	91466	91471	91477	91482
822	91487	91492	91498	91503	91508	91514	91519	91524	91529	91535
823	91540	91545	91551	91556	91561	91566	91572	91577	91582	91587
824	91593	91598	91603	91609	91614	91619	91624	91630	91635	91640
825	91645	91651	91656	91661	91666	91672	91677	91682	91687	91693
826	91698	91703	91709	91714	91719	91724	91730	91735	91740	91745
827	91751	91756	91761	91766	91772	91777	91782	91787	91793	91798
828	91803	91808	91814	91819	91824	91829	91834	91840	91845	91850
829	91855	91861	91866	91871	91876	91882	91887	91892	91897	91903
830	91908	91913	91918	91924	91929	91934	91939	91944	91950	91955
831	91960	91965	91971	91976	91981	91986	91991	91997	92002	92007
832	92012	92018	92023	92028	92033	92038	92044	92049	92054	92059
833	92065	92070	92075	92080	92085	92091	92096	92101	92106	92111
834	92117	92122	92127	92132	92137	92143	92148	92153	92158	92163
835	92169	92174	92179	92184	92189	92195	92200	92205	92210	92215
836	92221	92226	92231	92236	92241	92247	92252	92257	92262	92267
837	92273	92278	92283	92288	92293	92298	92304	92309	92314	92319
838	92324	92330	92335	92340	92345	92350	92355	92361	92366	92371
839	92376	92381	92387	92392	92397	92402	92407	92412	92418	92423
840	92428	92433	92438	92443	92449	92454	92459	92464	92469	92474
841	92480	92485	92490	92495	92500	92505	92511	92516	92521	92526
842	92531	92536	92542	92547	92552	92557	92562	92567	92572	92578
843	92583	92588	92593	92598	92603	92609	92614	92619	92624	92629
844	92634	92639	92645	92650	92655	92660	92665	92670	92675	92681
845	92686	92691	92696	92701	92706	92711	92716	92722	92727	92732
846	92737	92742	92747	92752	92758	92763	92768	92773	92778	92783
847	92788	92793	92799	92804	92809	92814	92819	92824	92829	92834
848	92840	92845	92850	92855	92860	92865	92870	92875	92881	92886
849	92891	92896	92901	92906	92911	92916	92921	92927	92932	92937
850	92942	92947	92952	92957	92962	92967	92973	92978	92983	92988
851	92993	92998	93003	93008	93013	93018	93024	93029	93034	93039
852	93044	93049	93054	93059	93064	93069	93075	93080	93085	93090
853	93095	93100	93105	93110	93115	93120	93125	93131	93136	93141
854	93146	93151	93156	93161	93166	93171	93176	93181	93186	93192
855	93197	93202	93207	93212	93217	93222	93227	93232	93237	93242
856	93247	93252	93258	93263	93268	93273	93278	93283	93288	93293
857	93298	93303	93308	93313	93318	93323	93328	93334	93339	93344
858	93349	93354	93359	93364	93369	93374	93379	93384	93389	93394
859	93399	93404	93409	93414	93420	93425	93430	93435	93440	93445
860	93450	93455	93460	93465	93470	93475	93480	93485	93490	93495
861	93500	93505	93510	93515	93520	93526	93531	93536	93541	93546
862	93551	93556	93561	93566	93571	93576	93581	93586	93591	93596
863	93601	93606	93611	93616	93621	93626	93631	93636	93641	93646
864	93651	93656	93661	93666	93671	93676	93682	93687	93692	93697
865	93702	93707	93712	93717	93722	93727	93732	93737	93742	93747
866	93752	93757	93762	93767	93772	93777	93782	93787	93792	93797
867	93802	93807	93812	93817	93822	93827	93832	93837	93842	93847
868	93852	93857	93862	93867	93872	93877	93882	93887	93892	93897
869	93902	93907	93912	93917	93922	93927	93932	93937	93942	93947
870	93952	93957	93962	93967	93972	93977	93982	93987	93992	93997
871	94002	94007	94012	94017	94022	94027	94032	94037	94042	94047
872	94052	94057	94062	94067	94072	94077	94082	94086	94091	94096
873	94101	94106	94111	94116	94121	94126	94131	94136	94141	94146
874	94151	94156	94161	94166	94171	94176	94181	94186	94191	94196
875	94201	94206	94211	94216	94221	94226	94231	94236	94240	94245
876	94250	94255	94260	94265	94270	94275	94280	94285	94290	94295
877	94300	94305	94310	94315	94320	94325	94330	94335	94340	94345
878	94349	94354	94359	94364	94369	94374	94379	94384	94389	94394
879	94399	94404	94409	94414	94419	94424	94429	94433	94438	94443
No.	0	1	2	3	4	5	6	7	8	9

	6
1	1
2	1
3	2
4	2
5	3
6	4
7	4
8	5
9	5

	5
1	1
2	1
3	2
4	2
5	3
6	3
7	4
8	4
9	5

	4
1	0
2	1
3	1
4	2
5	2
6	2
7	3
8	3
9	4

TABLE 42.

Logarithms of Numbers.

No. 8800——9400. Log. 94448——97313.

No.	0	1	2	3	4	5	6	7	8	9		
880	94448	94453	94458	94463	94468	94473	94478	94483	94488	94493		5
881	94498	94503	94507	94512	94517	94522	94527	94532	94537	94542		
882	94547	94552	94557	94562	94567	94571	94576	94581	94586	94591	1	1
883	94596	94601	94606	94611	94616	94621	94626	94630	94635	94640	2	1
884	94645	94650	94655	94660	94665	94670	94675	94680	94685	94689	3	2
885	94694	94699	94704	94709	94714	94719	94724	94729	94734	94738	4	2
886	94743	94748	94753	94758	94763	94768	94773	94778	94783	94787	5	3
887	94792	94797	94802	94807	94812	94817	94822	94827	94832	94836	6	3
888	94841	94846	94851	94856	94861	94866	94871	94876	94880	94885	7	4
889	94890	94895	94900	94905	94910	94915	94919	94924	94929	94934	8	4
890	94939	94944	94949	94954	94959	94963	94968	94973	94978	94983	9	5
891	94988	94993	94998	95002	95007	95012	95017	95022	95027	95032		
892	95036	95041	95046	95051	95056	95061	95066	95071	95075	95080		
893	95085	95090	95095	95100	95105	95109	95114	95119	95124	95129		
894	95134	95139	95143	95148	95153	95158	95163	95168	95173	95177		
895	95182	95187	95192	95197	95202	95207	95211	95216	95221	95226		
896	95231	95236	95240	95245	95250	95255	95260	95265	95270	95274		
897	95279	95284	95289	95294	95299	95303	95308	95313	95318	95323		
898	95328	95332	95337	95342	95347	95352	95357	95361	95366	95371		
899	95376	95381	95386	95390	95395	95400	95405	95410	95415	95419		
900	95424	95429	95434	95439	95444	95448	95453	95458	95463	95468		
901	95472	95477	95482	95487	95492	95497	95501	95506	95511	95516		
902	95521	95525	95530	95535	95540	95545	95550	95554	95559	95564		
903	95569	95574	95578	95583	95588	95593	95598	95602	95607	95612		
904	95617	95622	95626	95631	95636	95641	95646	95650	95655	95660		
905	95665	95670	95674	95679	95684	95689	95694	95698	95703	95708		
906	95713	95718	95722	95727	95732	95737	95742	95746	95751	95756		
907	95761	95766	95770	95775	95780	95785	95789	95794	95799	95804		
908	95809	95813	95818	95823	95828	95832	95837	95842	95847	95852		
909	95856	95861	95866	95871	95875	95880	95885	95890	95895	95899		
910	95904	95909	95914	95918	95923	95928	95933	95938	95942	95947		
911	95952	95957	95961	95966	95971	95976	95980	95985	95990	95995		
912	95999	96004	96009	96014	96019	96023	96028	96033	96038	96042		
913	96047	96052	96057	96061	96066	96071	96076	96080	96085	96090		
914	96095	96099	96104	96109	96114	96118	96123	96128	96133	96137		
915	96142	96147	96152	96156	96161	96166	96171	96175	96180	96185		
916	96190	96194	96199	96204	96209	96213	96218	96223	96227	96232		
917	96237	96242	96246	96251	96256	96261	96265	96270	96275	96280		
918	96284	96289	96294	96298	96303	96308	96313	96317	96322	96327		
919	96332	96336	96341	96346	96350	96355	96360	96365	96369	96374		
920	96379	96384	96388	96393	96398	96402	96407	96412	96417	96421		
921	96426	96431	96435	96440	96445	96450	96454	96459	96464	96468		
922	96473	96478	96483	96487	96492	96497	96501	96506	96511	96515		
923	96520	96525	96530	96534	96539	96544	96548	96553	96558	96562		
924	96567	96572	96577	96581	96586	96591	96595	96600	96605	96609		
925	96614	96619	96624	96628	96633	96638	96642	96647	96652	96656		
926	96661	96666	96670	96675	96680	96685	96689	96694	96699	96703		
927	96708	96713	96717	96722	96727	96731	96736	96741	96745	96750		
928	96755	96759	96764	96769	96774	96778	96783	96788	96792	96797		
929	96802	96806	96811	96816	96820	96825	96830	96834	96839	96844		4
930	96848	96853	96858	96862	96867	96872	96876	96881	96886	96890		
931	96895	96900	96904	96909	96914	96918	96923	96928	96932	96937	1	0
932	96942	96946	96951	96956	96960	96965	96970	96974	96979	96984	2	1
933	96988	96993	96997	97002	97007	97011	97016	97021	97025	97030	3	1
934	97035	97039	97044	97049	97053	97058	97063	97067	97072	97077	4	2
935	97081	97086	97090	97095	97100	97104	97109	97114	97118	97123	5	2
936	97128	97132	97137	97142	97146	97151	97155	97160	97165	97169	6	2
937	97174	97179	97183	97188	97192	97197	97202	97206	97211	97216	7	3
938	97220	97225	97230	97234	97239	97243	97248	97253	97257	97262	8	3
939	97267	97271	97276	97280	97285	97290	97294	97299	97304	97308	9	4
No.	0	1	2	3	4	5	6	7	8	9		

TABLE 42.

Logarithms of Numbers.

No. 9400——10000. Log. 97313——99996.

No.	0	1	2	3	4	5	6	7	8	9
940	97313	97317	97322	97327	97331	97336	97340	97345	97350	97354
941	97359	97364	97368	97373	97377	97382	97387	97391	97396	97400
942	97405	97410	97414	97419	97424	97428	97433	97437	97442	97447
943	97451	97456	97460	97465	97470	97474	97479	97483	97488	97493
944	97497	97502	97506	97511	97516	97520	97525	97529	97534	97539
945	97543	97548	97552	97557	97562	97566	97571	97575	97580	97585
946	97589	97594	97598	97603	97607	97612	97617	97621	97626	97630
947	97635	97640	97644	97649	97653	97658	97663	97667	97672	97676
948	97681	97685	97690	97695	97699	97704	97708	97713	97717	97722
949	97727	97731	97736	97740	97745	97749	97754	97759	97763	97768
950	97772	97777	97782	97786	97791	97795	97800	97804	97809	97813
951	97818	97823	97827	97832	97836	97841	97845	97850	97855	97859
952	97864	97868	97873	97877	97882	97886	97891	97896	97900	97905
953	97909	97914	97918	97923	97928	97932	97937	97941	97946	97950
954	97955	97959	97964	97968	97973	97978	97982	97987	97991	97996
955	98000	98005	98009	98014	98019	98023	98028	98032	98037	98041
956	98046	98050	98055	98059	98064	98068	98073	98078	98082	98087
957	98091	98096	98100	98105	98109	98114	98118	98123	98127	98132
958	98137	98141	98146	98150	98155	98159	98164	98168	98173	98177
959	98182	98186	98191	98195	98200	98204	98209	98214	98218	98223
960	98227	98232	98236	98241	98245	98250	98254	98259	98263	98268
961	98272	98277	98281	98286	98290	98295	98299	98304	98308	98313
962	98318	98322	98327	98331	98336	98340	98345	98349	98354	98358
963	98363	98367	98372	98376	98381	98385	98390	98394	98399	98403
964	98408	98412	98417	98421	98426	98430	98435	98439	98444	98448
965	98453	98457	98462	98466	98471	98475	98480	98484	98489	98493
966	98498	98502	98507	98511	98516	98520	98525	98529	98534	98538
967	98543	98547	98552	98556	98561	98565	98570	98574	98579	98583
968	98588	98592	98597	98601	98605	98610	98614	98619	98623	98628
969	98632	98637	98641	98646	98650	98655	98659	98664	98668	98673
970	98677	98682	98686	98691	98695	98700	98704	98709	98713	98717
971	98722	98726	98731	98735	98740	98744	98749	98753	98758	98762
972	98767	98771	98776	98780	98784	98789	98793	98798	98802	98807
973	98811	98816	98820	98825	98829	98834	98838	98843	98847	98851
974	98856	98860	98865	98869	98874	98878	98883	98887	98892	98896
975	98900	98905	98909	98914	98918	98923	98927	98932	98936	98941
976	98945	98949	98954	98958	98963	98967	98972	98976	98981	98985
977	98989	98994	98998	99003	99007	99012	99016	99021	99025	99029
978	99034	99038	99043	99047	99052	99056	99061	99065	99069	99074
979	99078	99083	99087	99092	99096	99100	99105	99109	99114	99118
980	99123	99127	99131	99136	99140	99145	99149	99154	99158	99162
981	99167	99171	99176	99180	99185	99189	99193	99198	99202	99207
982	99211	99216	99220	99224	99229	99233	99238	99242	99247	99251
983	99255	99260	99264	99269	99273	99277	99282	99286	99291	99295
984	99300	99304	99308	99313	99317	99322	99326	99330	99335	99339
985	99344	99348	99352	99357	99361	99366	99370	99374	99379	99383
986	99388	99392	99396	99401	99405	99410	99414	99419	99423	99427
987	99432	99436	99441	99445	99449	99454	99458	99463	99467	99471
988	99476	99480	99484	99489	99493	99498	99502	99506	99511	99515
989	99520	99524	99528	99533	99537	99542	99546	99550	99555	99559
990	99564	99568	99572	99577	99581	99585	99590	99594	99599	99603
991	99607	99612	99616	99621	99625	99629	99634	99638	99642	99647
992	99651	99656	99660	99664	99669	99673	99677	99682	99686	99691
993	99695	99699	99704	99708	99712	99717	99721	99726	99730	99734
994	99739	99743	99747	99752	99756	99760	99765	99769	99774	99778
995	99782	99787	99791	99795	99800	99804	99808	99813	99817	99822
996	99826	99830	99835	99839	99843	99848	99852	99856	99861	99865
997	99870	99874	99878	99883	99887	99891	99896	99900	99904	99909
998	99913	99917	99922	99926	99930	99935	99939	99944	99948	99952
999	99957	99961	99965	99970	99974	99978	99983	99987	99991	99996
No.	0	1	2	3	4	5	6	7	8	9

	5
1	1
2	1
3	2
4	2
5	3
6	3
7	4
8	4
9	5

	4
1	0
2	1
3	1
4	2
5	2
6	2
7	3
8	3
9	4

TABLE 43.

Logarithmic Sines, Tangents, and Secants to every Point and Quarter Point of the Compass.

Points.	Sine.	Cosine.	Tangent.	Cotangent.	Secant.	Cosecant.	
0	Inf. neg.	10.00000	Inf. neg.	Infinite.	10.00000	Infinite.	8
¼	8.69080	9.99948	8.69132	11.30868	10.00052	11.30920	7¾
½	8.99130	9.99790	8.99340	11.00660	10.00210	11.00870	7½
¾	9.16652	9.99527	9.17125	10.82875	10.00473	10.83348	7¼
1	9.29024	9.99157	9.29866	10.70134	10.00843	10.70976	7
1¼	9.38557	9.98679	9.39879	10.60121	10.01321	10.61443	6¾
1½	9.46282	9.98088	9.48194	10.51806	10.01912	10.53718	6½
1¾	9.52749	9.97384	9.55365	10.44635	10.02616	10.47251	6¼
2	9.58284	9.96562	9.61722	10.38278	10.03438	10.41716	6
2¼	9.63099	9.95616	9.67483	10.32517	10.04384	10.36901	5¾
2½	9.67339	9.94543	9.72796	10.27204	10.05457	10.32661	5½
2¾	9.71105	9.93335	9.77770	10.22230	10.06665	10.28895	5¼
3	9.74474	9.91985	9.82489	10.17511	10.08015	10.25526	5
3¼	9.77503	9.90483	9.87020	10.12980	10.09517	10.22497	4¾
3½	9.80236	9.88819	9.91417	10.08583	10.11181	10.19764	4½
3¾	9.82708	9.86979	9.95729	10.04271	10.13021	10.17292	4¼
4	9.84949	9.84949	10.00000	10.00000	10.15051	10.15051	4
	Cosine.	Sine.	Cotangent.	Tangent.	Cosecant.	Secant.	Points.

TABLE 44.

Log. Sines, Tangents, and Secants.

0° 179°

M.	Hour A. M.	Hour P. M.	Sine.	Diff. 1′.	Cosecant.	Tangent.	Diff. 1′.	Cotangent.	Secant.	Cosine.	M.
0	12 0 0	0 0 0	Inf. neg.		Infinite.	Inf. neg.		Infinite.	10.00000	10.00000	60
1	11 59 52	0 8	6.46373	30103	13.53627	6.46373	30103	13.53627	00000	00000	59
2	59 44	0 16	76476	17609	23524	76476	17609	23524	00000	00000	58
3	59 36	0 24	94085	12494	05915	94085	12494	05915	00000	00000	57
4	59 28	0 32	7.06579	9691	12.93421	7.06579	9691	12.93421	00000	00000	56
5	11 59 20	0 0 40	7.16270	7918	12.83730	7.16270	7918	12.83730	10.00000	10.00000	55
6	59 12	0 48	24188	6694	75812	24188	6694	75812	00000	00000	54
7	59 4	0 56	30882	5800	69118	30882	5800	69118	00000	00000	53
8	58 56	1 4	36682	5115	63318	36682	5115	63318	00000	00000	52
9	58 48	1 12	41797	4576	58203	41797	4576	58203	00000	00000	51
10	11 58 40	0 1 20	7.46373	4139	12.53627	7.46373	4139	12.53627	10.00000	10.00000	50
11	58 32	1 28	50512	3779	49488	50512	3779	49488	00000	00000	49
12	58 24	1 36	54291	3476	45709	54291	3476	45709	00000	00000	48
13	58 16	1 44	57767	3218	42233	57767	3219	42233	00000	00000	47
14	58 8	1 52	60985	2997	39015	60986	2996	39014	00000	00000	46
15	11 58 0	0 2 0	7.63982	2802	12.36018	7.63982	2803	12.36018	10.00000	10.00000	45
16	57 52	2 8	66784	2633	33216	66785	2633	33215	00000	00000	44
17	57 44	2 16	69417	2483	30583	69418	2482	30582	00001	9.99999	43
18	57 36	2 24	71900	2348	28100	71900	2348	28100	00001	99999	42
19	57 28	2 32	74248	2227	25752	74248	2228	25752	00001	99999	41
20	11 57 20	0 2 40	7.76475	2119	12.23525	7.76476	2119	12.23524	10.00001	9.99999	40
21	57 12	2 48	78594	2021	21406	78595	2020	21405	00001	99999	39
22	57 4	2 56	80615	1930	19385	80615	1931	19385	00001	99999	38
23	56 56	3 4	82545	1848	17455	82546	1848	17454	00001	99999	37
24	56 48	3 12	84393	1773	15607	84394	1773	15606	00001	99999	36
25	11 56 40	0 3 20	7.86166	1704	12.13834	7.86167	1704	12.13833	10.00001	9.99999	35
26	56 32	3 28	87870	1639	12130	87871	1639	12129	00001	99999	34
27	56 24	3 36	89509	1579	10491	89510	1579	10490	00001	99999	33
28	56 16	3 44	91088	1524	08912	91089	1524	08911	00001	99999	32
29	56 8	3 52	92612	1472	07388	92613	1473	07387	00002	99998	31
30	11 56 0	0 4 0	7.94084	1424	12.05916	7.94086	1424	12.05914	10.00002	9.99998	30
31	55 52	4 8	95508	1379	04492	95510	1379	04490	00002	99998	29
32	55 44	4 16	93887	1336	03113	96889	1336	03111	00002	99998	28
33	55 36	4 24	98223	1297	01777	98225	1297	01775	00002	99998	27
34	55 28	4 32	99520	1259	00480	99522	1259	00478	00002	99998	26
35	11 55 20	0 4 40	8.00779	1223	11.99221	8.00781	1223	11.99219	10.00002	9.99998	25
36	55 12	4 48	02002	1190	97998	02004	1190	97996	00002	99998	24
37	55 4	4 56	03192	1158	96808	03194	1159	96806	00003	99997	23
38	54 56	5 4	04350	1128	95650	04353	1128	95647	00003	99997	22
39	54 48	5 12	05478	1100	94522	05481	1100	94519	00003	99997	21
40	11 54 40	0 5 20	8.06578	1072	11.93422	8.06581	1072	11.93419	10.00003	9.99997	20
41	54 32	5 28	07650	1046	92350	07653	1047	92347	00003	99997	19
42	54 24	5 36	08696	1022	91304	08700	1022	91300	00003	99997	18
43	54 16	5 44	09718	999	90282	09722	998	90278	00003	99997	17
44	54 8	5 52	10717	976	89283	10720	976	89280	00004	99996	16
45	11 54 0	0 6 0	8.11693	954	11.88307	8.11696	955	11.88304	10.00004	9.99996	15
46	53 52	6 8	12647	934	87353	12651	934	87349	00004	99996	14
47	53 44	6 16	13581	914	86419	13585	915	86415	00004	99996	13
48	53 36	6 24	14495	896	85505	14500	895	85500	00004	99996	12
49	53 28	6 32	15391	877	84609	15395	878	84605	00004	99996	11
50	11 53 20	0 6 40	8.16268	860	11.83732	8.16273	860	11.83727	10.00005	9.99995	10
51	53 12	6 48	17128	843	82872	17133	843	82867	00005	99995	9
52	53 4	6 56	17971	827	82029	17976	828	82024	00005	99995	8
53	52 56	7 4	18798	812	81202	18804	812	81196	00005	99995	7
54	52 48	7 12	19610	797	80390	19616	797	80384	00005	99995	6
55	11 52 40	0 7 20	8.20407	782	11.79593	8.20413	782	11.79587	10.00006	9.99994	5
56	52 32	7 28	21189	769	78811	21195	769	78805	00006	99994	4
57	52 24	7 36	21958	755	78042	21964	756	78036	00006	99994	3
58	52 16	7 44	22713	743	77287	22720	742	77280	00006	99994	2
59	52 8	7 52	23456	730	76544	23462	730	76538	00006	99994	1
60	52 0	8 0	24186	717	75814	24192	718	75808	00007	99993	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff. 1′.	Secant.	Cotangent.	Diff. 1′.	Tangent.	Cosecant.	Sine.	M.

90° 89°

TABLE 44.

Log. Sines, Tangents, and Secants.

1° 179°

M.	Hour A. M.	Hour P. M.	Sine.	Diff. 1′.	Cosecant.	Tangent.	Diff. 1′.	Cotangent.	Secant.	Cosine.	M.
0	11 52 0	0 8 0	8.24186	717	11.75814	8.24192	718	11.75808	10.00007	9.99993	60
1	51 52	8 8	24903	706	75097	24910	706	75090	00007	99993	59
2	51 44	8 16	25609	695	74391	25616	696	74384	00007	99993	58
3	51 36	8 24	26304	684	73696	26312	684	73688	00007	99993	57
4	51 28	8 32	26988	673	73012	26996	673	73004	00008	99992	56
5	11 51 20	0 8 40	8.27661	663	11.72339	8.27669	663	11.72331	10.00008	9.99992	55
6	51 12	8 48	28324	653	71676	28332	654	71668	00008	99992	54
7	51 4	8 56	28977	644	71023	28986	643	71014	00008	99992	53
8	50 56	9 4	29621	634	70379	29629	634	70371	00008	99992	52
9	50 48	9 12	30255	624	69745	30263	625	69737	00009	99991	51
10	11 50 40	0 9 20	8.30879	616	11.69121	8.30888	617	11.69112	10.00009	9.99991	50
11	50 32	9 28	31495	608	68505	31505	607	68495	00009	99991	49
12	50 24	9 36	32103	599	67897	32112	599	67888	00010	99990	48
13	50 16	9 44	32702	590	67298	32711	591	67289	00010	99990	47
14	50 8	9 52	33292	583	66708	33302	584	66698	00010	99990	46
15	11 50 0	0 10 0	8.33875	575	11.66125	8.33886	575	11.66114	10.00010	9.99990	45
16	49 52	10 8	34450	568	65550	34461	568	65539	00011	99989	44
17	49 44	10 16	35018	560	64982	35029	561	64971	00011	99989	43
18	49 36	10 24	35578	553	64422	35590	553	64410	00011	99989	42
19	49 28	10 32	36131	547	63869	36143	546	63857	00011	99989	41
20	11 49 20	0 10 40	8.36678	539	11.63322	8.36689	540	11.63311	10.00012	9.99988	40
21	49 12	10 48	37217	533	62783	37229	533	62771	00012	99988	39
22	49 4	10 56	37750	526	62250	37762	527	62238	00012	99988	38
23	48 56	11 4	38276	520	61724	38289	520	61711	00013	99987	37
24	48 48	11 12	38796	514	61204	38809	514	61191	00013	99987	36
25	11 48 40	0 11 20	8.39310	508	11.60690	8.39323	509	11.60677	10.00013	9.99987	35
26	48 32	11 28	39818	502	60182	39832	502	60168	00014	99986	34
27	48 24	11 36	40320	496	59680	40334	496	59666	00014	99986	33
28	48 16	11 44	40816	491	59184	40830	491	59170	00014	99986	32
29	48 8	11 52	41307	485	58693	41321	486	58679	00015	99985	31
30	11 48 0	0 12 0	8.41792	480	11.58208	8.41807	480	11.58193	10.00015	9.99985	30
31	47 52	12 8	42272	474	57728	42287	475	57713	00015	99985	29
32	47 44	12 16	42746	470	57254	42762	470	57238	00016	99984	28
33	47 36	12 24	43216	464	56784	43232	464	56768	00016	99984	27
34	47 28	12 32	43680	459	56320	43696	460	56304	00016	99984	26
35	11 47 20	0 12 40	8.44139	455	11.55861	8.44156	455	11.55844	10.00017	9.99983	25
36	47 12	12 48	44594	450	55406	44611	450	55389	00017	99983	24
37	47 4	12 56	45044	445	54956	45061	446	54939	00017	99983	23
38	46 56	13 4	45489	441	54511	45507	441	54493	00018	99982	22
39	46 48	13 12	45930	436	54070	45948	437	54052	00018	99982	21
40	11 46 40	0 13 20	8.46366	433	11.53634	8.46385	432	11.53615	10.00018	9.99982	20
41	46 32	13 28	46799	427	53201	46817	428	53183	00019	99981	19
42	46 24	13 36	47226	424	52774	47245	424	52755	00019	99981	18
43	46 16	13 44	47650	419	52350	47669	420	52331	00019	99981	17
44	46 8	13 52	48069	416	51931	48089	416	51911	00020	99980	16
45	11 46 0	0 14 0	8.48485	411	11.51515	8.48505	412	11.51495	10.00020	9.99980	15
46	45 52	14 8	48896	408	51104	48917	408	51083	00021	99979	14
47	45 44	14 16	49304	404	50696	49325	404	50675	00021	99979	13
48	45 36	14 24	49708	400	50292	49729	401	50271	00021	99979	12
49	45 28	14 32	50108	396	49892	50130	397	49870	00022	99978	11
50	11 45 20	0 14 40	8.50504	393	11.49496	8.50527	393	11.49478	10.00022	9.99978	10
51	45 12	14 48	50897	390	49103	50920	390	49080	00023	99977	9
52	45 4	14 56	51287	386	48713	51310	386	48690	00023	99977	8
53	44 56	15 4	51673	382	48327	51696	383	48304	00023	99977	7
54	44 48	15 12	52055	379	47945	52079	380	47921	00024	99976	6
55	11 44 40	0 15 20	8.52434	376	11.47566	8.52459	376	11.47541	10.00024	9.99976	5
56	44 32	15 28	52810	373	47190	52835	373	47165	00025	99975	4
57	44 24	15 36	53183	369	46817	53208	370	46792	00025	99975	3
58	44 16	15 44	53552	367	46448	53578	367	46422	00026	99974	2
59	44 8	15 52	53919	363	46081	53945	363	46055	00026	99974	1
60	44 0	16 0	54282	360	45718	54308	361	45692	00026	99974	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff. 1′.	Secant.	Cotangent.	Diff. 1′.	Tangent.	Cosecant.	Sine.	M.

91° 88°

TABLE 44.

Log. Sines, Tangents, and Secants.

2° 177°

M.	Hour A. M.	Hour P. M.	Sine.	Diff. 1′.	Cosecant.	Tangent.	Diff. 1′.	Cotangent.	Secant.	Cosine.	M.
0	11 44 0	0 16 0	8.54282	360	11.45718	8.54308	361	11.45692	10.00026	9.99974	60
1	43 52	16 8	54642	357	45358	54669	358	45331	00027	99973	59
2	43 44	16 16	54999	355	45001	55027	355	44973	00027	99973	58
3	43 36	16 24	55354	351	44646	55382	352	44618	00028	99972	57
4	43 28	16 32	55705	349	44295	55734	349	44266	00028	99972	56
5	11 43 20	0 16 40	8.56054	346	11.43946	8.56083	346	11.43917	10.00029	9.99971	55
6	43 12	16 48	56400	343	43600	56429	344	43571	00029	99971	54
7	43 4	16 56	56743	341	43257	56773	341	43227	00030	99970	53
8	42 56	17 4	57084	337	42916	57114	338	42886	00030	99970	52
9	42 48	17 12	57421	336	42579	57452	336	42548	00031	99969	51
10	11 42 40	0 17 20	8.57757	332	11.42243	8.57788	333	11.42212	10.00031	9.99969	50
11	42 32	17 28	58089	330	41911	58121	330	41879	00032	99968	49
12	42 24	17 36	58419	328	41581	58451	328	41549	00032	99968	48
13	42 16	17 44	58747	325	41253	58779	326	41221	00033	99967	47
14	42 8	17 52	59072	323	40928	59105	323	40895	00033	99967	46
15	11 42 0	0 18 0	8.59395	320	11.40605	8.59428	321	11.40572	10.00033	9.99967	45
16	41 52	18 8	59715	318	40285	59749	319	40251	00034	99966	44
17	41 44	18 16	60033	316	39967	60068	316	39932	00034	99966	43
18	41 36	18 24	60349	313	39651	60384	314	39616	00035	99965	42
19	41 28	18 32	60662	311	39338	60698	311	39302	00036	99964	41
20	11 41 20	0 18 40	8.60973	309	11.39027	8.61009	310	11.38991	10.00036	9.99964	40
21	41 12	18 48	61282	307	38718	61319	307	38681	00037	99963	39
22	41 4	18 56	61589	305	38411	61626	305	38374	00037	99963	38
23	40 56	19 4	61894	302	38106	61931	303	38069	00038	99962	37
24	40 48	19 12	62196	301	37804	62234	301	37766	00038	99962	36
25	11 40 40	0 19 20	8.62497	298	11.37503	8.62535	299	11.37465	10.00039	9.99961	35
26	40 32	19 28	62795	296	37205	62834	297	37166	00039	99961	34
27	40 24	19 36	63091	294	36909	63131	295	36869	00040	99960	33
28	40 16	19 44	63385	293	36615	63426	292	36574	00040	99960	32
29	40 8	19 52	63678	290	36322	63718	291	36282	00041	99959	31
30	11 40 0	0 20 0	8.63968	288	11.36032	8.64009	289	11.35991	10.00041	9.99959	30
31	39 52	20 8	64256	287	35744	64298	287	35702	00042	99958	29
32	39 44	20 16	64543	284	35457	64585	285	35415	00042	99958	28
33	39 36	20 24	64827	283	35173	64870	284	35130	00043	99957	27
34	39 28	20 32	65110	281	34890	65154	281	34846	00044	99956	26
35	11 39 20	0 20 40	8.65391	279	11.34609	8.65435	280	11.34565	10.00044	9.99956	25
36	39 12	20 48	65670	277	34330	65715	278	34285	00045	99955	24
37	39 4	20 56	65947	276	34053	65993	276	34007	00045	99955	23
38	38 56	21 4	66223	274	33777	66269	274	33731	00046	99954	22
39	38 48	21 12	66497	272	33503	66543	273	33457	00046	99954	21
40	11 38 40	0 21 20	8.66769	270	11.33231	8.66816	271	11.33184	10.00047	9.99953	20
41	38 32	21 28	67039	269	32961	67087	269	32913	00048	99952	19
42	38 24	21 36	67308	267	32692	67356	268	32644	00048	99952	18
43	38 16	21 44	67575	266	32425	67624	266	32376	00049	99951	17
44	38 8	21 52	67841	263	32159	67890	264	32110	00049	99951	16
45	11 38 0	0 22 0	8.68104	263	11.31896	8.68154	263	11.31846	10.00050	9.99950	15
46	37 52	22 8	68367	260	31633	68417	261	31583	00051	99949	14
47	37 44	22 16	68627	259	31373	68678	260	31322	00051	99949	13
48	37 36	22 24	68886	258	31114	68938	258	31062	00052	99948	12
49	37 28	22 32	69144	256	30856	69196	257	30804	00052	99948	11
50	11 37 20	0 22 40	8.69400	254	11.30600	8.69453	255	11.30547	10.00053	9.99947	10
51	37 12	22 48	69654	253	30346	69708	254	30292	00054	99946	9
52	37 4	22 56	69907	252	30093	69962	252	30038	00054	99946	8
53	36 56	23 4	70159	250	29841	70214	251	29786	00055	99945	7
54	36 48	23 12	70409	249	29591	70465	249	29535	00056	99944	6
55	11 36 40	0 23 20	8.70658	247	11.29342	8.70714	248	11.29286	10.00056	9.99944	5
56	36 32	23 28	70905	246	29095	70962	246	29038	00057	99943	4
57	36 24	23 36	71151	244	28849	71208	245	28792	00058	99942	3
58	36 16	23 44	71395	243	28605	71453	244	28547	00058	99942	2
59	36 8	23 52	71638	242	28362	71697	243	28303	00059	99941	1
60	36 0	24 0	71880	240	28120	71940	241	28060	00060	99940	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff. 1′.	Secant.	Cotangent.	Diff. 1′.	Tangent.	Cosecant.	Sine.	M.

92° 87°

TABLE 44.

Log. Sines, Tangents, and Secants.

3° 176°

M.	Hour A. M.	Hour P. M.	Sine.	Diff. 1′.	Cosecant.	Tangent.	Diff. 1′.	Cotangent.	Secant.	Cosine.	M.
0	11 36 0	0 24 0	8.71880	240	11.28120	8.71940	241	11.28060	10.00060	9.99940	60
1	35 52	24 8	72120	239	27880	72181	239	27819	00060	99940	59
2	35 44	24 16	72359	238	27641	72420	239	27580	00061	99939	58
3	35 36	24 24	72597	237	27403	72659	237	27341	00062	99938	57
4	35 28	24 32	72834	235	27166	72896	236	27104	00062	99938	56
5	11 35 20	0 24 40	8.73069	234	11.26931	8.73132	234	11.26868	10.00063	9.99937	55
6	35 12	24 48	73303	232	26697	73366	234	26634	00064	99936	54
7	35 4	24 56	73535	232	26465	73600	232	26400	00064	99936	53
8	34 56	25 4	73767	230	26233	73832	231	26168	00065	99935	52
9	34 48	25 12	73997	229	26003	74063	229	25937	00066	99934	51
10	11 34 40	0 25 20	8.74226	228	11.25774	8.74292	229	11.25708	10.00066	9.99934	50
11	34 32	25 28	74454	226	25546	74521	227	25479	00067	99933	49
12	34 24	25 36	74680	226	25320	74748	226	25252	00068	99932	48
13	34 16	25 44	74906	224	25094	74974	225	25026	00068	99932	47
14	34 8	25 52	75130	223	24870	75199	224	24801	00069	99931	46
15	11 34 0	0 26 0	8.75353	222	11.24647	8.75423	222	11.24577	10.00070	9.99930	45
16	33 52	26 8	75575	220	24425	75645	222	24355	00071	99929	44
17	33 44	26 16	75795	220	24205	75867	220	24133	00071	99929	43
18	33 36	26 24	76015	219	23985	76087	219	23913	00072	99928	42
19	33 28	26 32	76234	217	23766	76306	219	23694	00073	99927	41
20	11 33 20	0 26 40	8.76451	216	11.23549	8.76525	217	11.23475	10.00074	9.99926	40
21	33 12	26 48	76667	216	23333	76742	216	23258	00074	99926	39
22	33 4	26 56	76883	214	23117	76958	215	23042	00075	99925	38
23	32 56	27 4	77097	213	22903	77173	214	22827	00076	99924	37
24	32 48	27 12	77310	212	22690	77387	213	22613	00077	99923	36
25	11 32 40	0 27 20	8.77522	211	11.22478	8.77600	211	11.22400	10.00077	9.99923	35
26	32 32	27 28	77733	210	22267	77811	211	22189	00078	99922	34
27	32 24	27 36	77943	209	22057	78022	210	21978	00079	99921	33
28	32 16	27 44	78152	208	21848	78232	209	21768	00080	99920	32
29	32 8	27 52	78360	208	21640	78441	208	21559	00080	99920	31
30	11 32 0	0 28 0	8.78568	206	11.21432	8.78649	206	11.21351	10.00081	9.99919	30
31	31 52	28 8	78774	205	21226	78855	206	21145	00082	99918	29
32	31 44	28 16	78979	204	21021	79061	205	20939	00083	99917	28
33	31 36	28 24	79183	203	20817	79266	204	20734	00083	99917	27
34	31 28	28 32	79386	202	20614	79470	203	20530	00084	99916	26
35	11 31 20	0 28 40	8.79588	201	11.20412	8.79673	202	11.20327	10.00085	9.99915	25
36	31 12	28 48	79789	201	20211	79875	201	20125	00086	99914	24
37	31 4	28 56	79990	199	20010	80076	201	19924	00087	99913	23
38	30 56	29 4	80189	199	19811	80277	199	19723	00087	99913	22
39	30 48	29 12	80388	197	19612	80476	198	19524	00088	99912	21
40	11 30 40	0 29 20	8.80585	197	11.19415	8.80674	198	11.19326	10.00089	9.99911	20
41	30 32	29 28	80782	196	19218	80872	196	19128	00090	99910	19
42	30 24	29 36	80978	195	19022	81068	196	18932	00091	99909	18
43	30 16	29 44	81173	194	18827	81264	195	18736	00091	99909	17
44	30 8	29 52	81367	193	18633	81459	194	18541	00092	99908	16
45	11 30 0	0 30 0	8.81560	192	11.18440	8.81653	193	11.18347	10.00093	9.99907	15
46	29 52	30 8	81752	192	18248	81846	192	18154	00094	99906	14
47	29 44	30 16	81944	190	18056	82038	192	17962	00095	99905	13
48	29 36	30 24	82134	190	17866	82230	190	17770	00096	99904	12
49	29 28	30 32	82324	189	17676	82420	190	17580	00096	99904	11
50	11 29 20	0 30 40	8.82513	188	11.17487	8.82610	189	11.17390	10.00097	9.99903	10
51	29 12	30 48	82701	187	17299	82799	188	17201	00098	99902	9
52	29 4	30 56	82888	187	17112	82987	188	17013	00099	99901	8
53	28 56	31 4	83075	186	16925	83175	186	16825	00100	99900	7
54	28 48	31 12	83261	185	16739	83361	186	16639	00101	99899	6
55	11 28 40	0 31 20	8.83446	184	11.16554	8.83547	185	11.16453	10.00102	9.99898	5
56	28 32	31 28	83630	183	16370	83732	184	16268	00102	99898	4
57	28 24	31 36	83813	183	16187	83916	184	16084	00103	99897	3
58	28 16	31 44	83996	181	16004	84100	182	15900	00104	99896	2
59	28 8	31 52	84177	181	15823	84282	182	15718	00105	99895	1
60	28 0	32 0	84358	181	15642	84464	182	15536	00106	99894	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff. 1′.	Secant.	Cotangent.	Diff. 1′.	Tangent.	Cosecant.	Sine	M.

93° 86°

TABLE 44.

Log. Sines, Tangents, and Secants.

4° 175°

M.	Hour A. M.	Hour P. M.	Sine.	Diff. 1'.	Cosecant.	Tangent.	Diff. 1'.	Cotangent.	Secant.	Cosine.	M.
0	11 28 0	0 32 0	8.84358	181	11.15642	8.84464	182	11.15536	10.00106	9.99894	60
1	27 52	32 8	84539	179	15461	84646	180	15354	00107	99893	59
2	27 44	32 16	84718	179	15282	84826	180	15174	00108	99892	58
3	27 36	32 24	84897	178	15103	85006	179	14994	00109	99891	57
4	27 28	32 32	85075	177	14925	85185	178	14815	00109	99891	56
5	11 27 20	0 32 40	8.85252	177	11.14748	8.85363	177	11.14637	10.00110	9.99890	55
6	27 12	32 48	85429	176	14571	85540	177	14460	00111	99889	54
7	27 4	32 56	85605	175	14395	85717	176	14283	00112	99888	53
8	26 56	33 4	85780	175	14220	85893	176	14107	00113	99887	52
9	26 48	33 12	85955	173	14045	86069	174	13931	00114	99886	51
10	11 26 40	0 33 20	8.86128	173	11.13872	8.86243	174	11.13757	10.00115	9.99885	50
11	26 32	33 28	86301	173	13699	86417	174	13583	00116	99884	49
12	26 24	33 36	86474	171	13526	86591	172	13409	00117	99883	48
13	26 16	33 44	86645	171	13355	86763	172	13237	00118	99882	47
14	26 8	33 52	86816	171	13184	86935	171	13065	00119	99881	46
15	11 26 0	0 34 0	8.86987	169	11.13013	8.87106	171	11.12894	10.00120	9.99880	45
16	25 52	34 8	87156	169	12844	87277	170	12723	00121	99879	44
17	25 44	34 16	87325	169	12675	87447	169	12553	00121	99879	43
18	25 36	34 24	87494	167	12506	87616	169	12384	00122	99878	42
19	25 28	34 32	87661	168	12339	87785	168	12215	00123	99877	41
20	11 25 20	0 34 40	8.87829	166	11.12171	8.87953	167	11.12047	10.00124	9.99876	40
21	25 12	34 48	87995	166	12005	88120	167	11880	00125	99875	39
22	25 4	34 56	88161	165	11839	88287	166	11713	00126	99874	38
23	24 56	35 4	88326	164	11674	88453	165	11547	00127	99873	37
24	24 48	35 12	88490	164	11510	88618	165	11382	00128	99872	36
25	11 24 40	0 35 20	8.88654	163	11.11346	8.88783	165	11.11217	10.00129	9.99871	35
26	24 32	35 28	88817	163	11183	88948	163	11052	00130	99870	34
27	24 24	35 36	88980	162	11020	89111	163	10889	00131	99869	33
28	24 16	35 44	89142	162	10858	89274	163	10726	00132	99868	32
29	24 8	35 52	89304	160	10696	89437	161	10563	00133	99867	31
30	11 24 0	0 36 0	8.89464	161	11.10536	8.89598	162	11.10402	10.00134	9.99866	30
31	23 52	36 8	89625	159	10375	89760	160	10240	00135	99865	29
32	23 44	36 16	89784	159	10216	89920	160	10080	00136	99864	28
33	23 36	36 24	89943	159	10057	90080	160	09920	00137	99863	27
34	23 28	36 32	90102	158	09898	90240	159	09760	00138	99862	26
35	11 23 20	0 36 40	8.90260	157	11.09740	8.90399	158	11.09601	10.00139	9.99861	25
36	23 12	36 48	90417	157	09583	90557	158	09443	00140	99860	24
37	23 4	36 56	90574	156	09426	90715	157	09285	00141	99859	23
38	22 56	37 4	90730	155	09270	90872	157	09128	00142	99858	22
39	22 48	37 12	90885	155	09115	91029	156	08971	00143	99857	21
40	11 22 40	0 37 20	8.91040	155	11.08960	8.91185	155	11.08815	10.00144	9.99856	20
41	22 32	37 28	91195	154	08805	91340	155	08660	00145	99855	19
42	22 24	37 36	91349	153	08651	91495	155	08505	00146	99854	18
43	22 16	37 44	91502	153	08498	91650	153	08350	00147	99853	17
44	22 8	37 52	91655	152	08345	91803	154	08197	00148	99852	16
45	11 22 0	0 38 0	8.91807	152	11.08193	8.91957	153	11.08043	10.00149	9.99851	15
46	21 52	38 8	91959	151	08041	92110	152	07890	00150	99850	14
47	21 44	38 16	92110	151	07890	92262	152	07738	00152	99848	13
48	21 36	38 24	92261	150	07739	92414	151	07586	00153	99847	12
49	21 28	38 32	92411	150	07589	92565	151	07435	00154	99846	11
50	11 21 20	0 38 40	8.92561	149	11.07439	8.92716	150	11.07284	10.00155	9.99845	10
51	21 12	38 48	92710	149	07290	92866	150	07134	00156	99844	9
52	21 4	38 56	92859	148	07141	93016	149	06984	00157	99843	8
53	20 56	39 4	93007	147	06993	93165	148	06835	00158	99842	7
54	20 48	39 12	93154	147	06846	93313	149	06687	00159	99841	6
55	11 20 40	0 39 20	8.93301	147	11.06699	8.93462	147	11.06538	10.00160	9.99840	5
56	20 32	39 28	93448	146	06552	93609	147	06391	00161	99839	4
57	20 24	39 36	93594	146	06406	93756	147	06244	00162	99838	3
58	20 16	39 44	93740	145	06260	93903	146	06097	00163	99837	2
59	20 8	39 52	93885	145	06115	94049	146	05951	00164	99836	1
60	20 0	40 0	94030	144	05970	94195	145	05805	00166	99834	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff. 1'.	Secant.	Cotangent.	Diff. 1'.	Tangent.	Cosecant.	Sine.	M.

94° 85°

TABLE 44.

Log. Sines, Tangents, and Secants.

5°			A		A	B		B	C		C	174°
M.	Hour A. M.	Hour P. M.	Sine.	Diff.	Cosecant.	Tangent.	Diff.	Cotangent.	Secant.	Diff.	Cosine.	M.
0	11 20 00	0 40 00	8. 94030	0	11. 05970	8. 94195	0	11. 05805	10. 00166	0	9. 99834	60
1	19 52	40 08	94174	2	05826	94340	2	05660	00167	0	99833	59
2	19 44	40 16	94317	4	05683	94485	4	05515	00168	0	99832	58
3	19 36	40 24	94461	7	05539	94630	7	05370	00169	0	99831	57
4	19 28	40 32	94603	9	05397	94773	9	05227	00170	0	99830	56
5	11 19 20	0 40 40	8. 94746	11	11. 05254	8. 94917	11	11. 05083	10. 00171	0	9. 99829	55
6	19 12	40 48	94887	13	05113	95060	13	04940	00172	0	99828	54
7	19 04	40 56	95029	15	04971	95202	15	04798	00173	0	99827	53
8	18 56	41 04	95170	18	04830	95344	18	04656	00175	0	99825	52
9	18 48	41 12	95310	20	04690	95486	20	04514	00176	0	99824	51
10	11 18 40	0 41 20	8. 95450	22	11. 04550	8. 95627	22	11. 04373	10. 00177	0	9. 99823	50
11	18 32	41 28	95589	24	04411	95767	24	04233	00178	0	99822	49
12	18 24	41 36	95728	26	04272	95908	27	04092	00179	0	99821	48
13	18 16	41 44	95867	29	04133	96047	29	03953	00180	0	99820	47
14	18 08	41 52	96005	31	03995	96187	31	03813	00181	0	99819	46
15	11 18 00	0 42 00	8. 96143	33	11. 03857	8. 96325	33	11. 03675	10. 00183	0	9. 99817	45
16	17 52	42 08	96280	35	03720	96464	35	03536	00184	0	99816	44
17	17 44	42 16	96417	37	03583	96602	38	03398	00185	0	99815	43
18	17 36	42 24	96553	39	03447	96739	40	03261	00186	0	99814	42
19	17 28	42 32	96689	42	03311	96877	42	03123	00187	0	99813	41
20	11 17 20	0 42 40	8. 96825	44	11. 03175	8. 97013	44	11. 02987	10. 00188	0	9. 99812	40
21	17 12	42 48	96960	46	03040	97150	46	02850	00190	0	99810	39
22	17 04	42 56	97095	48	02905	97285	49	02715	00191	0	99809	38
23	16 56	43 04	97229	50	02771	97421	51	02579	00192	0	99808	37
24	16 48	43 12	97363	53	02637	97556	53	02444	00193	0	99807	36
25	11 16 40	0 43 20	8. 97496	55	11. 02504	8. 97691	55	11. 02309	10. 00194	1	9. 99806	35
26	16 32	43 28	97629	57	02371	97825	58	02175	00196	1	99804	34
27	16 24	43 36	97762	59	02238	97959	60	02041	00197	1	99803	33
28	16 16	43 44	97894	61	02106	98092	62	01908	00198	1	99802	32
29	16 08	43 52	98026	64	01974	98225	64	01775	00199	1	99801	31
30	11 16 00	0 44 00	8. 98157	66	11. 01843	8. 98358	66	11. 01642	10. 00200	1	9. 99800	30
31	15 52	44 08	98288	68	01712	98490	69	01510	00202	1	99798	29
32	15 44	44 16	98419	70	01581	98622	71	01378	00203	1	99797	28
33	15 36	44 24	98549	72	01451	98753	73	01247	00204	1	99796	27
34	15 28	44 32	98679	75	01321	98884	75	01116	00205	1	99795	26
35	11 15 20	0 44 40	8. 98808	77	11. 01192	8. 99015	77	11. 00985	10. 00207	1	9. 99793	25
36	15 12	44 48	98937	79	01063	99145	80	00855	00208	1	99792	24
37	15 04	44 56	99066	81	00934	99275	82	00725	00209	1	99791	23
38	14 56	45 04	99194	83	00806	99405	84	00595	00210	1	99790	22
39	14 48	45 12	99322	86	00678	99534	86	00466	00212	1	99788	21
40	11 14 40	0 45 20	8. 99450	88	11. 00550	8. 99662	89	11. 00338	10. 00213	1	9. 99787	20
41	14 32	45 28	99577	90	00423	99791	91	00209	00214	1	99786	19
42	14 24	45 36	99704	92	00296	99919	93	00081	00215	1	99785	18
43	14 16	45 44	99830	94	00170	9. 00046	95	10. 99954	00217	1	99783	17
44	14 08	45 52	99956	96	00044	00174	97	99826	00218	1	99782	16
45	11 14 00	0 46 00	9. 00082	99	10. 99918	9. 00301	100	10. 99699	10. 00219	1	9. 99781	15
46	13 52	46 08	00207	101	99793	00427	102	99573	00220	1	99780	14
47	13 44	46 16	00332	103	99668	00553	104	99447	00222	1	99778	13
48	13 36	46 24	00456	105	99544	00679	106	99321	00223	1	99777	12
49	13 28	46 32	00581	107	99419	00805	108	99195	00224	1	99776	11
50	11 13 20	0 46 40	9. 00704	110	10. 99296	9. 00930	111	10. 99070	10. 00225	1	9. 99775	10
51	13 12	46 48	00828	112	99172	01055	113	98945	00227	1	99773	9
52	13 04	46 56	00951	114	99049	01179	115	98821	00228	1	99772	8
53	12 56	47 04	01074	116	98926	01303	117	98697	00229	1	99771	7
54	12 48	47 12	01196	118	98804	01427	120	98573	00231	1	99769	6
55	11 12 40	0 47 20	9. 01318	121	10. 98682	9. 01550	122	10. 98450	10. 00232	1	99768	5
56	12 32	47 28	01440	123	98560	01673	124	98327	00233	1	99767	4
57	12 24	47 36	01561	125	98439	01796	126	98204	00235	1	99765	3
58	12 16	47 44	01682	127	98318	01918	128	98082	00236	1	99764	2
59	12 08	47 52	01803	129	98197	02040	131	97960	00237	1	99763	1
60	12 00	48 00	01923	132	98077	02162	133	97838	00239	1	99761	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff.	Secant.	Cotangent.	Diff.	Tangent.	Cosecant.	Diff.	Sine.	M.
95°			A		A	B		B	C		C	84°

Seconds of time		1^{s}	2^{s}	3^{s}	4^{s}	5^{s}	6^{s}	7^{s}
Prop. parts of cols.	A	16	33	49	66	82	99	115
	B	17	33	50	66	83	100	116
	C	0	0	0	1	1	1	1

TABLE 44.

Log. Sines, Tangents, and Secants.

6°			A		A	B		B	C		C	173°
M.	Hour A. M.	Hour P. M.	Sine.	Diff.	Cosecant.	Tangent.	Diff.	Cotangent.	Secant.	Diff.	Cosine.	M.
0	11 12 00	0 48 00	9.01923	0	10.98077	9.02162	0	10.97838	10.00239	0	9.99761	60
1	11 52	48 08	02043	2	97957	02283	2	97717	00240	0	99760	59
2	11 44	48 16	02163	4	97837	02404	4	97596	00241	0	99759	58
3	11 36	48 24	02283	6	97717	02525	6	97475	00243	0	99757	57
4	11 28	48 32	02402	7	97598	02645	8	97355	00244	0	99756	56
5	11 11 20	0 48 40	9.02520	9	10.97480	9.02766	9	10.97234	10.00245	0	9.99755	55
6	11 12	48 48	02639	11	97361	02885	11	97115	00247	0	99753	54
7	11 04	48 56	02757	13	97243	03005	13	96995	00248	0	99752	53
8	10 56	49 04	02874	15	97126	03124	15	96876	00249	0	99751	52
9	10 48	49 12	02992	17	97008	03242	17	96758	00251	0	99749	51
10	11 10 40	0 49 20	9.03109	19	10.96891	9.03361	19	10.96639	10.00252	0	9.99748	50
11	10 32	49 28	03226	20	96774	03479	21	96521	00253	0	99747	49
12	10 24	49 36	03342	22	96658	03597	23	96403	00255	0	99745	48
13	10 16	49 44	03458	24	96542	03714	24	96286	00256	0	99744	47
14	10 08	49 52	03574	26	96426	03832	26	96168	00258	0	99742	46
15	11 10 00	0 50 00	9.03690	28	10.96310	9.03948	28	10.96052	10.00259	0	9.99741	45
16	9 52	50 08	03805	30	96195	04065	30	95935	00260	0	99740	44
17	9 44	50 16	03920	31	96080	04181	32	95819	00262	0	99738	43
18	9 36	50 24	04034	33	95966	04297	34	95703	00263	0	99737	42
19	9 28	50 32	04149	35	95851	04413	36	95587	00264	0	99736	41
20	11 9 20	0 50 40	9.04262	37	10.95738	9.04528	38	10.95472	10.00266	0	9.99734	40
21	9 12	50 48	04376	39	95624	04643	39	95357	00267	1	99733	39
22	9 04	50 56	04490	41	95510	04758	41	95242	00269	1	99731	38
23	8 56	51 04	04603	43	95397	04873	43	95127	00270	1	99730	37
24	8 48	51 12	04715	44	95285	04987	45	95013	00272	1	99728	36
25	11 8 40	0 51 20	9.04828	46	10.95172	9.05101	47	10.94899	10.00273	1	9.99727	35
26	8 32	51 28	04940	48	95060	05214	49	94786	00274	1	99726	34
27	8 24	51 36	05052	50	94948	05328	51	94672	00276	1	99724	33
28	8 16	51 44	05164	52	94836	05441	53	94559	00277	1	99723	32
29	8 08	51 52	05275	54	94725	05553	54	94447	00279	1	99721	31
30	11 8 00	0 52 00	9.05386	56	10.94614	9.05666	56	10.94334	10.00280	1	9.99720	30
31	7 52	52 08	05497	57	94503	05778	58	94222	00282	1	99718	29
32	7 44	52 16	05607	59	94393	05890	60	94110	00283	1	99717	28
33	7 36	52 24	05717	61	94283	06002	62	93998	00284	1	99716	27
34	7 28	52 32	05827	63	94173	06113	64	93887	00286	1	99714	26
35	11 7 20	0 52 40	9.05937	65	10.94063	9.06224	66	10.93776	10.00287	1	9.99713	25
36	7 12	52 48	06046	67	93954	06335	68	93665	00289	1	99711	24
37	7 04	52 56	06155	69	93845	06445	69	93555	00290	1	99710	23
38	6 56	53 04	06264	70	93736	06556	71	93444	00292	1	99708	22
39	6 48	53 12	06372	72	93628	06666	73	93334	00293	1	99707	21
40	11 6 40	0 53 20	9.06481	74	10.93519	9.06775	75	10.93225	10.00295	1	9.99705	20
41	6 32	53 28	06589	76	93411	06885	77	93115	00296	1	99704	19
42	6 24	53 36	06696	78	93304	06994	79	93006	00298	1	99702	18
43	6 16	53 44	06804	80	93196	07103	81	92897	00299	1	99701	17
44	6 08	53 52	06911	81	93089	07211	83	92789	00301	1	99699	16
45	11 6 00	0 54 00	9.07018	83	10.92982	9.07320	84	10.92680	10.00302	1	9.99698	15
46	5 52	54 08	07124	85	92876	07428	86	92572	00304	1	99696	14
47	5 44	54 16	07231	87	92769	07536	88	92464	00305	1	99695	13
48	5 36	54 24	07337	89	92663	07643	90	92357	00307	1	99693	12
49	5 28	54 32	07442	91	92558	07751	92	92249	00308	1	99692	11
50	11 5 20	0 54 40	9.07548	93	10.92452	9.07858	94	10.92142	10.00310	1	9.99690	10
51	5 12	54 48	07653	94	92347	07964	96	92036	00311	1	99689	9
52	5 04	54 56	07758	96	92242	08071	98	91929	00313	1	99687	8
53	4 56	55 04	07863	98	92137	08177	99	91823	00314	1	99686	7
54	4 48	55 12	07968	100	92032	08283	101	91717	00316	1	99684	6
55	11 4 40	0 55 20	9.08072	102	10.91928	9.08389	103	10.91611	10.00317	1	9.99683	5
56	4 32	55 28	08176	104	91824	08495	105	91505	00319	1	99681	4
57	4 24	55 36	08280	106	91720	08600	107	91400	00320	1	99680	3
58	4 16	55 44	08383	107	91617	08705	109	91295	00322	1	99678	2
59	4 08	55 52	08486	109	91514	08810	111	91190	00323	1	99677	1
60	4 00	56 00	08589	111	91411	08914	113	91086	00325	1	99675	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff.	Secant.	Cotangent.	Diff.	Tangent.	Cosecant.	Diff.	Sine.	M.
96°			A		A	B		B	C		C	83°

Seconds of time		1s	2s	3s	4s	5s	6s	7s
Prop. parts of cols.	A	14	28	42	56	69	83	97
	B	14	28	42	56	70	84	98
	C	0	0	1	1	1	1	1

TABLE 44.

Log. Sines, Tangents, and Secants.

7°			A		A	B		B	C		C	172°
M.	Hour A. M.	Hour P. M.	Sine.	Diff.	Cosecant.	Tangent.	Diff.	Cotangent.	Secant.	Diff.	Cosine.	M.
0	11 4 0	0 56 0	9. 08589	0	10. 91411	9. 08914	0	10. 91086	10. 00325	0	9. 99675	60
1	3 52	56 8	08692	2	91308	09019	2	90981	00326	0	99674	59
2	3 44	56 16	08795	3	91205	09123	3	90877	00328	0	99672	58
3	3 36	56 24	08897	5	91103	09227	5	90773	00330	0	99670	57
4	3 28	56 32	08999	6	91001	09330	7	90670	00331	0	99669	56
5	11 3 20	0 56 40	9. 09101	8	10. 90899	9. 09434	8	10. 90566	10. 00333	0	9. 99667	55
6	3 12	56 48	09202	10	90798	09537	10	90463	00334	0	99666	54
7	3 4	56 56	09304	11	90696	09640	11	90360	00336	0	99664	53
8	2 56	57 4	09405	13	90595	09742	13	90258	00337	0	99663	52
9	2 48	57 12	09506	14	90494	09845	15	90155	00339	0	99661	51
10	11 2 40	0 57 20	9. 09606	16	10. 90394	9. 09947	16	10. 90053	10. 00341	0	9. 99659	50
11	2 32	57 28	09707	18	90293	10049	18	89951	00342	0	99658	49
12	2 24	57 36	09807	19	90193	10150	20	89850	00344	0	99656	48
13	2 16	57 44	09907	21	90093	10252	21	89748	00345	0	99655	47
14	2 8	57 52	10006	22	89994	10353	23	89647	00347	0	99653	46
15	11 2 0	0 58 0	9. 10106	24	10. 89894	9. 10454	24	10. 89546	10. 00349	0	9. 99651	45
16	1 52	58 8	10205	26	89795	10555	26	89445	00350	0	99650	44
17	1 44	58 16	10304	27	89696	10656	28	89344	00352	0	99648	43
18	1 36	58 24	10402	29	89598	10756	29	89244	00353	1	99647	42
19	1 28	58 32	10501	30	89499	10856	31	89144	00355	1	99645	41
20	11 1 20	0 58 40	9. 10599	32	10. 89401	9. 10956	33	10. 89044	10. 00357	1	9. 99643	40
21	1 12	58 48	10697	34	89303	11056	34	88944	00358	1	99642	39
22	1 4	58 56	10795	35	89205	11155	36	88845	00360	1	99640	38
23	0 56	59 4	10893	37	89107	11254	37	88746	00362	1	99638	37
24	0 48	59 12	10990	38	89010	11353	39	88647	00363	1	99637	36
25	11 0 40	0 59 20	9. 11087	40	10. 88913	9. 11452	41	10. 88548	10. 00365	1	9. 99635	35
26	0 32	59 28	11184	42	88816	11551	42	88449	00367	1	99633	34
27	0 24	59 36	11281	43	88719	11649	44	88351	00368	1	99632	33
28	0 16	59 44	11377	45	88623	11747	46	88253	00370	1	99630	32
29	0 8	59 52	11474	46	88526	11845	47	88155	00371	1	99629	31
30	11 0 0	1 0 0	9. 11570	48	10. 88430	9. 11943	49	10. 88057	10. 00373	1	9. 99627	30
31	10 59 52	0 8	11666	50	88334	12040	51	87960	00375	1	99625	29
32	59 44	0 16	11761	51	88239	12138	52	87862	00376	1	99624	28
33	59 36	0 24	11857	53	88143	12235	54	87765	00378	1	99622	27
34	59 28	0 32	11952	54	88048	12332	55	87668	00380	1	99620	26
35	10 59 20	1 0 40	9. 12047	56	10. 87953	9. 12428	57	10. 87572	10. 00382	1	9. 99618	25
36	59 12	0 48	12142	58	87858	12525	59	87475	00383	1	99617	24
37	59 4	0 56	12236	59	87764	12621	60	87379	00385	1	99615	23
38	58 56	1 4	12331	61	87669	12717	62	87283	00387	1	99613	22
39	58 48	1 12	12425	62	87575	12813	64	87187	00388	1	99612	21
40	10 58 40	1 1 20	9. 12519	64	10. 87481	9. 12909	65	10. 87091	10. 00390	1	9. 99610	20
41	58 32	1 28	12612	66	87388	13004	67	86996	00392	1	99608	19
42	58 24	1 36	12706	67	87294	13099	68	86901	00393	1	99607	18
43	58 16	1 44	12799	69	87201	13194	70	86806	00395	1	99605	17
44	58 8	1 52	12892	70	87108	13289	72	86711	00397	1	99603	16
45	10 58 0	1 2 0	9. 12985	72	10. 87015	9. 13384	73	10. 86616	10. 00399	1	9. 99601	15
46	57 52	2 8	13078	74	86922	13478	75	86522	00400	1	99600	14
47	57 44	2 16	13171	75	86829	13573	77	86427	00402	1	99598	13
48	57 36	2 24	13263	77	86737	13667	78	86333	00404	1	99596	12
49	57 28	2 32	13355	78	86645	13761	80	86239	00405	1	99595	11
50	10 57 20	1 2 40	9. 13447	80	10. 86553	9. 13854	81	10. 86146	10. 00407	1	9. 99593	10
51	57 12	2 48	13539	82	86461	13948	83	86052	00409	1	99591	9
52	57 4	2 56	13630	83	86370	14041	85	85959	00411	1	99589	8
53	56 56	3 4	13722	85	86278	14134	86	85866	00412	1	99588	7
54	56 48	3 12	13813	87	86187	14227	88	85773	00414	2	99586	6
55	10 56 40	1 3 20	9. 13904	88	10. 86096	9. 14320	90	10. 85680	10. 00416	2	9. 99584	5
56	56 32	3 28	13994	90	86006	14412	91	85588	00418	2	99582	4
57	56 24	3 36	14085	91	85915	14504	93	85496	00419	2	99581	3
58	56 16	3 44	14175	93	85825	14597	95	85403	00421	2	99579	2
59	56 8	3 52	14266	95	85734	14688	96	85312	00423	2	99577	1
60	56 0	4 0	14356	96	85644	14780	98	85220	00425	2	99575	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff.	Secant.	Cotangent.	Diff.	Tangent.	Cosecant.	Diff.	Sine.	M.
97°			A		A	B		B	C		C	82°

Seconds of time		1ˢ	2ˢ	3ˢ	4ˢ	5ˢ	6ˢ	7ˢ
Prop. parts of cols.	A	12	24	36	48	60	72	84
	B	12	24	37	49	61	73	86
	C	0	0	1	1	1	1	1

TABLE 44.

Log. Sines, Tangents, and Secants.

8°			A		A	B		B	C		C	171°
M.	Hour A. M.	Hour P. M.	Sine.	Diff.	Cosecant.	Tangent.	Diff.	Cotangent.	Secant.	Diff.	Cosine.	M.
0	10 56 0	1 4 0	9. 14356	0	10. 85644	9. 14780	0	10. 85220	10. 00425	0	9. 99575	60
1	55 52	4 8	14445	1	85555	14872	1	85128	00426	0	99574	59
2	55 44	4 16	14535	3	85465	14963	3	85037	00428	0	99572	58
3	55 36	4 24	14624	4	85376	15054	4	84946	00430	0	99570	57
4	55 28	4 32	14714	6	85286	15145	6	84855	00432	0	99568	56
5	10 55 20	1 4 40	9. 14803	7	10. 85197	9. 15236	7	10. 84764	10. 00434	0	9. 99566	55
6	55 12	4 48	14891	8	85109	15327	9	84673	00435	0	99565	54
7	55 4	4 56	14980	10	85020	15417	10	84583	00437	0	99563	53
8	54 56	5 4	15069	11	84931	15508	12	84492	00439	0	99561	52
9	54 48	5 12	15157	13	84843	15598	13	84402	00441	0	99559	51
10	10 54 40	1 5 20	9. 15245	14	10. 84755	9. 15688	14	10. 84312	10. 00443	0	9. 99557	50
11	54 32	5 28	15333	16	84667	15777	16	84223	00444	0	99556	49
12	54 24	5 36	15421	17	84579	15867	17	84133	00446	0	99554	48
13	54 16	5 44	15508	18	84492	15956	19	84044	00448	0	99552	47
14	54 8	5 52	15596	20	84404	16046	20	83954	00450	0	99550	46
15	10 54 0	1 6 0	9. 15683	21	10. 84317	9. 16135	22	10. 83865	10. 00452	0	9. 99548	45
16	53 52	6 8	15770	23	84230	16224	23	83776	00454	1	99546	44
17	53 44	6 16	15857	24	84143	16312	25	83688	00455	1	99545	43
18	53 36	6 24	15944	25	84056	16401	26	83599	00457	1	99543	42
19	53 28	6 32	16030	27	83970	16489	27	83511	00459	1	99541	41
20	10 53 20	1 6 40	9. 16116	28	10. 83884	9. 16577	29	10. 83423	10. 00461	1	9. 99539	40
21	53 12	6 48	16203	30	83797	16665	30	83335	00463	1	99537	39
22	53 4	6 56	16289	31	83711	16753	32	83247	00465	1	99535	38
23	52 56	7 4	16374	32	83626	16841	33	83159	00467	1	99533	37
24	52 48	7 12	16460	34	83540	16928	35	83072	00468	1	99532	36
25	10 52 40	1 7 20	9. 16545	35	10. 83455	9. 17016	36	10. 82984	10. 00470	1	9. 99530	35
26	52 32	7 28	16631	37	83369	17103	37	82897	00472	1	99528	34
27	52 24	7 36	16716	38	83284	17190	39	82810	00474	1	99526	33
28	52 16	7 44	16801	39	83199	17277	40	82723	00476	1	99524	32
29	52 8	7 52	16886	41	83114	17363	42	82637	00478	1	99522	31
30	10 52 0	1 8 0	9. 16970	42	10. 83030	9. 17450	43	10. 82550	10. 00480	1	9. 99520	30
31	51 52	8 8	17055	44	82945	17536	45	82464	00482	1	99518	29
32	51 44	8 16	17139	45	82861	17622	46	82378	00483	1	99517	28
33	51 36	8 24	17223	47	82777	17708	48	82292	00485	1	99515	27
34	51 28	8 32	17307	48	82693	17794	49	82206	00487	1	99513	26
35	10 51 20	1 8 40	9. 17391	49	10. 82609	9. 17880	50	10. 82120	10. 00489	1	9. 99511	25
36	51 12	8 48	17474	51	82526	17965	52	82035	00491	1	99509	24
37	51 4	8 56	17558	52	82442	18051	53	81949	00493	1	99507	23
38	50 56	9 4	17641	54	82359	18136	55	81864	00495	1	99505	22
39	50 48	9 12	17724	55	82276	18221	56	81779	00497	1	99503	21
40	10 50 40	1 9 20	9. 17807	56	10. 82193	9. 18306	58	10. 81694	10. 00499	1	9. 99501	20
41	50 32	9 28	17890	58	82110	18391	59	81609	00501	1	99499	19
42	50 24	9 36	17973	59	82027	18475	61	81525	00503	1	99497	18
43	50 16	9 44	18055	61	81945	18560	62	81440	00505	1	99495	17
44	50 8	9 52	18137	62	81863	18644	63	81356	00506	1	99494	16
45	10 50 0	1 10 0	9. 18220	63	10. 81780	9. 18728	65	10. 81272	10. 00508	1	9. 99492	15
46	49 52	10 8	18302	65	81698	18812	66	81188	00510	1	99490	14
47	49 44	10 16	18383	66	81617	18896	68	81104	00512	1	99488	13
48	49 36	10 24	18465	68	81535	18979	69	81021	00514	2	99486	12
49	49 28	10 32	18547	69	81453	19063	71	80937	00516	2	99484	11
50	10 49 20	1 10 40	9. 18628	71	10. 81372	9. 19146	72	10. 80854	10. 00518	2	9. 99482	10
51	49 12	10 48	18709	72	81291	19229	74	80771	00520	2	99480	9
52	49 4	10 56	18790	73	81210	19312	75	80688	00522	2	99478	8
53	48 56	11 4	18871	75	81129	19395	76	80605	00524	2	99476	7
54	48 48	11 12	18952	76	81048	19478	78	80522	00526	2	99474	6
55	10 48 40	1 11 20	9. 19033	78	10. 80967	9. 19561	79	10. 80439	10. 00528	2	9. 99472	5
56	48 32	11 28	19113	79	80887	19643	81	80357	00530	2	99470	4
57	48 24	11 36	19193	80	80807	19725	82	80275	00532	2	99468	3
58	48 16	11 44	19273	82	80727	19807	84	80193	00534	2	99466	2
59	48 8	11 52	19353	83	80647	19889	85	80111	00536	2	99464	1
60	48 0	12 0	19433	85	80567	19971	87	80029	00538	2	99462	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff.	Secant.	Cotangent.	Diff.	Tangent.	Cosecant.	Diff.	Sine.	M.
98°			A		A	B		B	C		C	81°

Seconds of time		1ˢ	2ˢ	3ˢ	4ˢ	5ˢ	6ˢ	7ˢ
Prop. parts of cols.	A	11	21	32	42	53	63	74
	B	11	22	32	43	54	65	76
	C	0	0	1	1	1	1	2

TABLE 44.

Log. Sines, Tangents, and Secants.

9°			A		A	B		B	C		C	170°
M.	Hour A. M.	Hour P. M.	Sine.	Diff.	Cosecant.	Tangent.	Diff.	Cotangent.	Secant.	Diff.	Cosine.	M.
0	10 48 0	1 12 0	9. 19433	0	10. 80567	9. 19971	0	10. 80029	10. 00538	0	9. 99462	60
1	47 52	12 8	19513	1	80487	20053	1	79947	00540	0	99460	59
2	47 44	12 16	19592	3	80408	20134	3	79865	00542	0	99458	58
3	47 36	12 24	19672	4	80328	20216	4	79784	00544	0	99456	57
4	47 28	12 32	19751	5	80249	20297	5	79703	00546	0	99454	56
5	10 47 20	1 12 40	9. 19830	6	10. 80170	9. 20378	6	10. 79622	10. 00548	0	9. 99452	55
6	47 12	12 48	19909	8	80091	20459	8	79541	00550	0	99450	54
7	47 4	12 56	19988	9	80012	20540	9	79460	00552	0	99448	53
8	46 56	13 4	20067	10	79933	20621	10	79379	00554	0	99446	52
9	46 48	13 12	20145	11	79855	20701	12	79299	00556	0	99444	51
10	10 46 40	1 13 20	9. 20223	13	10. 79777	9. 20782	13	10. 79218	10. 00558	0	9. 99442	50
11	46 32	13 28	20302	14	79698	20862	14	79138	00560	0	99440	49
12	46 24	13 36	20380	15	79620	20942	16	79058	00562	0	99438	48
13	46 16	13 44	20458	16	79542	21022	17	78978	00564	0	99436	47
14	46 8	13 52	20535	18	79465	21102	18	78898	00566	0	99434	46
15	10 46 0	1 14 0	9. 20613	19	10. 79387	9. 21182	19	10. 78818	10. 00568	1	9. 99432	45
16	45 52	14 8	20691	20	79309	21261	21	78739	00571	1	99429	44
17	45 44	14 16	20768	21	79232	21341	22	78659	00573	1	99427	43
18	45 36	14 24	20845	23	79155	21420	23	78580	00575	1	99425	42
19	45 28	14 32	20922	24	79078	21499	25	78501	00577	1	99423	41
20	10 45 20	1 14 40	9. 20999	25	10. 79001	9. 21578	26	10. 78422	10. 00579	1	9. 99421	40
21	45 12	14 48	21076	26	78924	21657	27	78343	00581	1	99419	39
22	45 4	14 56	21153	28	78847	21736	28	78264	00583	1	99417	38
23	44 56	15 4	21229	29	78771	21814	30	78186	00585	1	99415	37
24	44 48	15 12	21306	30	78694	21893	31	78107	00587	1	99413	36
25	10 44 40	1 15 20	9. 21382	31	10. 78618	9. 21971	32	10. 78029	10. 00589	1	9. 99411	35
26	44 32	15 28	21458	33	78542	22049	34	77951	00591	1	99409	34
27	44 24	15 36	21534	34	78466	22127	35	77873	00593	1	99407	33
28	44 16	15 44	21610	35	78390	22205	36	77795	00596	1	99404	32
29	44 8	15 52	21685	37	78315	22283	38	77717	00598	1	99402	31
30	10 44 0	1 16 0	9. 21761	38	10. 78239	9. 22361	39	10. 77639	10. 00600	1	9. 99400	30
31	43 52	16 8	21836	39	78164	22438	40	77562	00602	1	99398	29
32	43 44	16 16	21912	40	78088	22516	41	77484	00604	1	99396	28
33	43 36	16 24	21987	42	78013	22593	43	77407	00606	1	99394	27
34	43 28	16 32	22062	43	77938	22670	44	77330	00608	1	99392	26
35	10 43 20	1 16 40	9. 22137	44	10. 77863	9. 22747	45	10. 77253	10. 00610	1	9. 99390	25
36	43 12	16 48	22211	45	77789	22824	47	77176	00612	1	99388	24
37	43 4	16 56	22286	47	77714	22901	48	77099	00615	1	99385	23
38	42 56	17 4	22361	48	77639	22977	49	77023	00617	1	99383	22
39	42 48	17 12	22435	49	77565	23054	50	76946	00619	1	99381	21
40	10 42 40	1 17 20	9. 22509	50	10. 77491	9. 23130	52	10. 76870	10. 00621	1	9. 99379	20
41	42 32	17 28	22583	52	77417	23206	53	76794	00623	1	99377	19
42	42 24	17 36	22657	53	77343	23283	54	76717	00625	1	99375	18
43	42 16	17 44	22731	54	77269	23359	56	76641	00628	2	99372	17
44	42 8	17 52	22805	55	77195	23435	57	76565	00630	2	99370	16
45	10 42 0	1 18 0	9. 22878	57	10. 77122	9. 23510	58	10. 76490	10. 00632	2	9. 99368	15
46	41 52	18 8	22952	58	77048	23586	60	76414	00634	2	99366	14
47	41 44	18 16	23025	59	76975	23661	61	76339	00636	2	99364	13
48	41 36	18 24	23098	60	76902	23737	62	76263	00638	2	99362	12
49	41 28	18 32	23171	62	76829	23812	63	76188	00641	2	99359	11
50	10 41 20	1 18 40	9. 23244	63	10. 76756	9. 23887	65	10. 76113	10. 00643	2	9. 99357	10
51	41 12	18 48	23317	64	76683	23962	66	76038	00645	2	99355	9
52	41 4	18 56	23390	65	76610	24037	67	75963	00647	2	99353	8
53	40 56	19 4	23462	67	76538	24112	69	75888	00649	2	99351	7
54	40 48	19 12	23535	68	76465	24186	70	75814	00652	2	99348	6
55	10 40 40	1 19 20	9. 23607	69	10. 76393	9. 24261	71	10. 75739	10. 00654	2	9. 99346	5
56	40 32	19 28	23679	71	76321	24335	73	75665	00656	2	99344	4
57	40 24	19 36	23752	72	76248	24410	74	75590	00658	2	99342	3
58	40 16	19 44	23823	73	76177	24484	75	75516	00660	2	99340	2
59	40 8	19 52	23895	74	76105	24558	76	75442	00663	2	99337	1
60	40 0	20 0	23967	76	76033	24632	78	75368	00665	2	99335	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff.	Secant.	Cotangent.	Diff.	Tangent.	Cosecant.	Diff.	Sine.	M.
99°			A		A	B		B	C		C	80°

Seconds of time.......		1s	2s	3s	4s	5s	6s	7s
Prop. parts of cols.	A	9	19	28	38	47	57	66
	B	10	19	29	39	49	58	68
	C	0	1	1	1	1	2	2

TABLE 44.

Log. Sines, Tangents, and Secants.

10°			A		A	B		B	C		C	169°
M.	Hour A. M.	Hour P. M.	Sine.	Diff.	Cosecant.	Tangent.	Diff.	Cotangent.	Secant.	Diff.	Cosine.	M.
0	10 40 0	1 20 0	9. 23967	0	10. 76033	9. 24632	0	10. 75368	10. 00665	0	9. 99335	60
1	39 52	20 8	24039	1	75961	24706	1	75294	00667	0	99333	59
2	39 44	20 16	24110	2	75890	24779	2	75221	00669	0	99331	58
3	39 36	20 24	24181	3	75819	24853	4	75147	00672	0	99328	57
4	39 28	20 32	24253	5	75747	24926	5	75074	00674	0	99326	56
5	10 39 20	1 20 40	9. 24324	6	10. 75676	9. 25000	6	10. 75000	10. 00676	0	9. 99324	55
6	39 12	20 48	24395	7	75605	25073	7	74927	00678	0	99322	54
7	39 4	20 56	24466	8	75534	25146	8	74854	00681	0	99319	53
8	38 56	21 4	24536	9	75464	25219	9	74781	00683	0	99317	52
9	38 48	21 12	24607	10	75393	25292	11	74708	00685	0	99315	51
10	10 38 40	1 21 20	9. 24677	11	10. 75323	9. 25365	12	10. 74635	10. 00687	0	9. 99313	50
11	38 32	21 28	24748	13	75252	25437	13	74563	00690	0	99310	49
12	38 24	21 36	24818	14	75182	25510	14	74490	00692	0	99308	48
13	38 16	21 44	24888	15	75112	25582	15	74418	00694	1	99306	47
14	38 8	21 52	24958	16	75042	25655	16	74345	00696	1	99304	46
15	10 38 0	1 22 0	9. 25028	17	10. 74972	9. 25727	18	10. 74273	10. 00699	1	9. 99301	45
16	37 52	22 8	25098	18	74902	25799	19	74201	00701	1	99299	44
17	37 44	22 16	25168	19	74832	25871	20	74129	00703	1	99297	43
18	37 36	22 24	25237	20	74763	25943	21	74057	00706	1	99294	42
19	37 28	22 32	25307	22	74693	26015	22	73985	00708	1	99292	41
20	10 37 20	1 22 40	9. 25376	23	10. 74624	9. 26086	24	10. 73914	10. 00710	1	9. 99290	40
21	37 12	22 48	25445	24	74555	26158	25	73842	00712	1	99288	39
22	37 4	22 56	25514	25	74486	26229	26	73771	00715	1	99285	38
23	36 56	23 4	25583	26	74417	26301	27	73699	00717	1	99283	37
24	36 48	23 12	25652	27	74348	26372	28	73628	00719	1	99281	36
25	10 36 40	1 23 20	9. 25721	28	10. 74279	9. 26443	29	10. 73557	10. 00722	1	9. 99278	35
26	36 32	23 28	25790	30	74210	26514	31	73486	00724	1	99276	34
27	36 24	23 36	25858	31	74142	26585	32	73415	00726	1	99274	33
28	36 16	23 44	25927	32	74073	26655	33	73345	00729	1	99271	32
29	36 8	23 52	25995	33	74005	26726	34	73274	00731	1	99269	31
30	10 36 0	1 24 0	9. 26063	34	10. 73937	9. 26797	35	10. 73203	10. 00733	1	9. 99267	30
31	35 52	24 8	26131	35	73869	26867	36	73133	00736	1	99264	29
32	35 44	24 16	26199	36	73801	26937	38	73063	00738	1	99262	28
33	35 36	24 24	26267	38	73733	27008	39	72992	00740	1	99260	27
34	35 28	24 32	26335	39	73665	27078	40	72922	00743	1	99257	26
35	10 35 20	1 24 40	9. 26403	40	10. 73597	9. 27148	41	10. 72852	10. 00745	1	9. 99255	25
36	35 12	24 48	26470	41	73530	27218	42	72782	00748	1	99252	24
37	35 4	24 56	26538	42	73462	27288	44	72712	00750	1	99250	23
38	34 56	25 4	26605	43	73395	27357	45	72643	00752	1	99248	22
39	34 48	25 12	26672	44	73328	27427	46	72573	00755	2	99245	21
40	10 34 40	1 25 20	9. 26739	45	10. 73261	9. 27496	47	10. 72504	10. 00757	2	9. 99243	20
41	34 32	25 28	26806	47	73194	27566	48	72434	00759	2	99241	19
42	34 24	25 36	26873	48	73127	27635	49	72365	00762	2	99238	18
43	34 16	25 44	26940	49	73060	27704	51	72296	00764	2	99236	17
44	34 8	25 52	27007	50	72993	27773	52	72227	00767	2	99233	16
45	10 34 0	1 26 0	9. 27073	51	10. 72927	9. 27842	53	10. 72158	10. 00769	2	9. 99231	15
46	33 52	26 8	27140	52	72860	27911	54	72089	00771	2	99229	14
47	33 44	26 16	27206	53	72794	27980	55	72020	00774	2	99226	13
48	33 36	26 24	27273	55	72727	28049	56	71951	00776	2	99224	12
49	33 28	26 32	27339	56	72661	28117	58	71883	00779	2	99221	11
50	10 33 20	1 26 40	9. 27405	57	10. 72595	9. 28186	59	10. 71814	10. 00781	2	9. 99219	10
51	33 12	26 48	27471	58	72529	28254	60	71746	00783	2	99217	9
52	33 4	26 56	27537	59	72463	28323	61	71677	00786	2	99214	8
53	32 56	27 4	27602	60	72398	28391	62	71609	00788	2	99212	7
54	32 48	27 12	27668	61	72332	28459	63	71541	00791	2	99209	6
55	10 32 40	1 27 20	9. 27734	63	10. 72266	9. 28527	65	10. 71473	10. 00793	2	9. 99207	5
56	32 32	27 28	27799	64	72201	28595	66	71405	00796	2	99204	4
57	32 24	27 36	27864	65	72136	28662	67	71338	00798	2	99202	3
58	32 16	27 44	27930	66	72070	28730	68	71270	00800	2	99200	2
59	32 8	27 52	27995	67	72005	28798	69	71202	00803	2	99197	1
60	32 0	28 0	28060	68	71940	28865	71	71135	00805	2	99195	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff.	Secant.	Cotangent.	Diff.	Tangent.	Cosecant.	Diff.	Sine.	M.
100°			A		A	B		B	C		C	79°

Seconds of time		1s	2s	3s	4s	5s	6s	7s
Prop. parts of cols.	A	9	17	26	34	43	51	60
	B	9	18	26	35	44	53	62
	C	0	1	1	1	1	2	2

TABLE 44.

Log. Sines, Tangents, and Secants.

11°			A		A	B		B	C		C	168°
M.	Hour A. M.	Hour P. M.	Sine.	Diff.	Cosecant.	Tangent.	Diff.	Cotangent.	Secant.	Diff.	Cosine.	M.
0	10 32 0	1 28 0	9. 28060	0	10. 71940	9. 28865	0	10. 71135	10. 00805	0	9. 99195	60
1	31 52	28 8	28125	1	71875	28933	1	71067	00808	0	99192	59
2	31 44	28 16	28190	2	71810	29000	2	71000	00810	0	99190	58
3	31 36	28 24	28254	3	71746	29067	3	70933	00813	0	99187	57
4	31 28	28 32	28319	4	71681	29134	4	70866	00815	0	99185	56
5	10 31 20	1 28 40	9. 28384	5	10. 71616	9. 29201	5	10. 70799	10. 00818	0	9. 99182	55
6	31 12	28 48	28448	6	71552	29268	6	70732	00820	0	99180	54
7	31 4	28 56	28512	7	71488	29335	8	70665	00823	0	99177	53
8	30 56	29 4	28577	8	71423	29402	9	70598	00825	0	99175	52
9	30 48	29 12	28641	9	71359	29468	10	70532	00828	0	99172	51
10	10 30 40	1 29 20	9. 28705	10	10. 71295	9. 29535	11	10. 70465	10. 00830	0	9. 99170	50
11	30 32	29 28	28769	11	71231	29601	12	70399	00833	0	99167	49
12	30 24	29 36	28833	12	71167	29668	13	70332	00835	1	99165	48
13	30 16	29 44	28896	13	71104	29734	14	70266	00838	1	99162	47
14	30 8	29 52	28960	14	71040	29800	15	70200	00840	1	99160	46
15	10 30 0	1 30 0	9. 29024	16	10. 70976	9. 29866	16	10. 70134	10. 00843	1	9. 99157	45
16	29 52	30 8	29087	17	70913	29932	17	70068	00845	1	99155	44
17	29 44	30 16	29150	18	70850	29998	18	70002	00848	1	99152	43
18	29 36	30 24	29214	19	70786	30064	19	69936	00850	1	99150	42
19	29 28	30 32	29277	20	70723	30130	20	69870	00853	1	99147	41
20	10 29 20	1 30 40	9. 29340	21	10. 70660	9. 30195	22	10. 69805	10. 00855	1	9. 99145	40
21	29 12	30 48	29403	22	70597	30261	23	69739	00858	1	99142	39
22	29 4	30 56	29466	23	70534	30326	24	69674	00860	1	99140	38
23	28 56	31 4	29529	24	70471	30391	25	69609	00863	1	99137	37
24	28 48	31 12	29591	25	70409	30457	26	69543	00865	1	99135	36
25	10 28 40	1 31 20	9. 29654	26	10. 70346	9. 30522	27	10. 69478	10. 00868	1	9. 99132	35
26	28 32	31 28	29716	27	70284	30587	28	69413	00870	1	99130	34
27	28 24	31 36	29779	28	70221	30652	29	69348	00873	1	99127	33
28	28 16	31 44	29841	29	70159	30717	30	69283	00876	1	99124	32
29	28 8	31 52	29903	30	70097	30782	31	69218	00878	1	99122	31
30	10 28 0	1 32 0	9. 29966	31	10. 70034	9. 30846	32	10. 69154	10. 00881	1	9. 99119	30
31	27 52	32 8	30028	32	69972	30911	33	69089	00883	1	99117	29
32	27 44	32 16	30090	33	69910	30975	35	69025	00886	1	99114	28
33	27 36	32 24	30151	34	69849	31040	36	68960	00888	1	99112	27
34	27 28	32 32	30213	35	69787	31104	37	68896	00891	1	99109	26
35	10 27 20	1 32 40	9. 30275	36	10. 69725	9. 31168	38	10. 68832	10. 00894	2	9. 99106	25
36	27 12	32 48	30336	37	69664	31233	39	68767	00896	2	99104	24
37	27 4	32 56	30398	38	69602	31297	40	68703	00899	2	99101	23
38	26 56	33 4	30459	39	69541	31361	41	68639	00901	2	99099	22
39	26 48	33 12	30521	40	69479	31425	42	68575	00904	2	99096	21
40	10 26 40	1 33 20	9. 30582	41	10. 69418	9. 31489	43	10. 68511	10. 00907	2	9. 99093	20
41	26 32	33 28	30643	42	69357	31552	44	68448	00909	2	99091	19
42	26 24	33 36	30704	43	69296	31616	45	68384	00912	2	99088	18
43	26 16	33 44	30765	45	69235	31679	46	68321	00914	2	99086	17
44	26 8	33 52	30826	46	69174	31743	47	68257	00917	2	99083	16
45	10 26 0	1 34 0	9. 30887	47	10. 69113	9. 31806	49	10. 68194	10. 00920	2	9. 99080	15
46	25 52	34 8	30947	48	69053	31870	50	68130	00922	2	99078	14
47	25 44	34 16	31008	49	68992	31933	51	68067	00925	2	99075	13
48	25 36	34 24	31068	50	68932	31996	52	68004	00928	2	99072	12
49	25 28	34 32	31129	51	68871	32059	53	67941	00930	2	99070	11
50	10 25 20	1 34 40	9. 31189	52	10. 68811	9. 32122	54	10. 67878	10. 00933	2	9. 99067	10
51	25 12	34 48	31250	53	68750	32185	55	67815	00936	2	99064	9
52	25 4	34 56	31310	54	68690	32248	56	67752	00938	2	99062	8
53	24 56	35 4	31370	55	68630	32311	57	67689	00941	2	99059	7
54	24 48	35 12	31430	56	68570	32373	58	67627	00944	2	99056	6
55	10 24 40	1 35 20	9. 31490	57	10. 68510	9. 32436	59	10. 67564	10. 00946	2	9. 99054	5
56	24 32	35 28	31549	58	68451	32498	60	67502	00949	2	99051	4
57	24 24	35 36	31609	59	68391	32561	61	67439	00952	2	99048	3
58	24 16	35 44	31669	60	68331	32623	63	67377	00954	2	99046	2
59	24 8	35 52	31728	61	68272	32685	64	67315	00957	3	99043	1
60	24 0	36 0	31788	62	68212	32747	65	67253	00960	3	99040	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff.	Secant.	Cotangent.	Diff.	Tangent.	Cosecant.	Diff.	Sine.	M.
101°			A		A	B		B	C		C	78°

Seconds of time		1s	2s	3s	4s	5s	6s	7s
Prop. parts of cols.	A	8	16	23	31	39	47	54
	B	8	16	24	32	40	49	57
	C	0	1	1	1	2	2	2

TABLE 44.

Log. Sines, Tangents, and Secants.

12°			A		A	B		B	C		C	167°
M.	Hour A. M.	Hour P. M.	Sine.	Diff.	Cosecant.	Tangent.	Diff.	Cotangent.	Secant.	Diff.	Cosine.	M.
0	10 24 0	1 36 0	9. 31788	0	10. 68212	9. 32747	0	10. 67253	10. 00960	0	9. 99040	60
1	23 52	36 8	31847	1	68153	32810	1	67190	00962	0	99038	59
2	23 44	36 16	31907	2	68093	32872	2	67128	00965	0	99035	58
3	23 36	36 24	31966	3	68034	32933	3	67067	00968	0	99032	57
4	23 28	36 32	32025	4	67975	32995	4	67005	00970	0	99030	56
5	10 23 20	1 36 40	9. 32084	5	10. 67916	9. 33057	5	10. 66943	10. 00973	0	9. 99027	55
6	23 12	36 48	32143	6	67857	33119	6	66881	00976	0	99024	54
7	23 4	36 56	32202	7	67798	33180	7	66820	00978	0	99022	53
8	22 56	37 4	32261	8	67739	33242	8	66758	00981	0	99019	52
9	22 48	37 12	32319	9	67681	33303	9	66697	00984	0	99016	51
10	10 22 40	1 37 20	9. 32378	10	10. 67622	9. 33365	10	10. 66635	10. 00987	0	9. 99013	50
11	22 32	37 28	32437	10	67563	33426	11	66574	00989	1	99011	49
12	22 24	37 36	32495	11	67505	33487	12	66513	00992	1	99008	48
13	22 16	37 44	32553	12	67447	33548	13	66452	00995	1	99005	47
14	22 8	37 52	32612	13	67388	33609	14	66391	00998	1	99002	46
15	10 22 0	1 38 0	9. 32670	14	10. 67330	9. 33670	15	10. 66330	10. 01000	1	9. 99000	45
16	21 52	38 8	32728	15	67272	33731	16	66269	01003	1	98997	44
17	21 44	38 16	32786	16	67214	33792	17	66208	01006	1	98994	43
18	21 36	38 24	32844	17	67156	33853	18	66147	01009	1	98991	42
19	21 28	38 32	32902	18	67098	33913	19	66087	01011	1	98989	41
20	10 21 20	1 38 40	9. 32960	19	10. 67040	9. 33974	20	10. 66026	10. 01014	1	9. 98986	40
21	21 12	38 48	33018	20	66982	34034	21	65966	01017	1	98983	39
22	21 4	38 56	33075	21	66925	34095	22	65905	01020	1	98980	38
23	20 56	39 4	33133	22	66867	34155	23	65845	01022	1	98978	37
24	20 48	39 12	33190	23	66810	34215	24	65785	01025	1	98975	36
25	10 20 40	1 39 20	9. 33248	24	10. 66752	9. 34276	25	10. 65724	10. 01028	1	9. 98972	35
26	20 32	39 28	33305	25	66695	34336	26	65664	01031	1	98969	34
27	20 24	39 36	33362	26	66638	34396	27	65604	01033	1	98967	33
28	20 16	39 44	33420	27	66580	34456	28	65544	01036	1	98964	32
29	20 8	39 52	33477	28	66523	34516	29	65484	01039	1	98961	31
30	10 20 0	1 40 0	9. 33534	29	10. 66466	9. 34576	30	10. 65424	10. 01042	1	9. 98958	30
31	19 52	40 8	33591	29	66409	34635	31	65365	01045	1	98955	29
32	19 44	40 16	33647	30	66353	34695	32	65305	01047	1	98953	28
33	19 36	40 24	33704	31	66296	34755	33	65245	01050	2	98950	27
34	19 28	40 32	33761	32	66239	34814	34	65186	01053	2	98947	26
35	10 19 20	1 40 40	9. 33818	33	10. 66182	9. 34874	35	10. 65126	10. 01056	2	9. 98944	25
36	19 12	40 48	33874	34	66126	34933	36	65067	01059	2	98941	24
37	19 4	40 56	33931	35	66069	34992	37	65008	01062	2	98938	23
38	18 56	41 4	33987	36	66013	35051	38	64949	01064	2	98936	22
39	18 48	41 12	34043	37	65957	35111	39	64889	01067	2	98933	21
40	10 18 40	1 41 20	9. 34100	38	10. 65900	9. 35170	40	10. 64830	10. 01070	2	9. 98930	20
41	18 32	41 28	34156	39	65844	35229	41	64771	01073	2	98927	19
42	18 24	41 36	34212	40	65788	35288	42	64712	01076	2	98924	18
43	18 16	41 44	34268	41	65732	35347	43	64653	01079	2	98921	17
44	18 8	41 52	34324	42	65676	35405	44	64595	01081	2	98919	16
45	10 18 0	1 42 0	9. 34380	43	10. 65620	9. 35464	45	10. 64536	10. 01084	2	9. 98916	15
46	17 52	42 8	34436	44	65564	35523	46	64477	01087	2	98913	14
47	17 44	42 16	34491	45	65509	35581	47	64419	01090	2	98910	13
48	17 36	42 24	34547	46	65453	35640	48	64360	01093	2	98907	12
49	17 28	42 32	34602	47	65398	35698	49	64302	01096	2	98904	11
50	10 17 20	1 42 40	9. 34658	48	10. 65342	9. 35757	50	10. 64243	10. 01099	2	9. 98901	10
51	17 12	42 48	34713	48	65287	35815	51	64185	01102	2	98898	9
52	17 4	42 56	34769	49	65231	35873	52	64127	01104	2	98896	8
53	16 56	43 4	34824	50	65176	35931	53	64069	01107	2	98893	7
54	16 48	43 12	34879	51	65121	35989	54	64011	01110	3	98890	6
55	10 16 40	1 43 20	9. 34934	52	10. 65066	9. 36047	55	10. 63953	10. 01113	3	9. 98887	5
56	16 32	43 28	34989	53	65011	36105	56	63895	01116	3	98884	4
57	16 24	43 36	35044	54	64956	36163	57	63837	01119	3	98881	3
58	16 16	43 44	35099	55	64901	36221	58	63779	01122	3	98878	2
59	16 8	43 52	35154	56	64846	36279	59	63721	01125	3	98875	1
60	16 0	44 0	35209	57	64791	36336	60	63664	01128	3	98872	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff.	Secant.	Cotangent.	Diff.	Tangent.	Cosecant.	Diff.	Sine.	M.
102°			A		A	B		B	C		C	77°

Seconds of time		1s	2s	3s	4s	5s	6s	7s
Prop. parts of cols.	A	7	14	21	29	36	43	50
	B	7	15	22	30	37	45	52
	C	0	1	1	1	2	2	2

TABLE 44.

Log. Sines, Tangents, and Secants.

13°			A		A	B		B	C		C	166°
M.	Hour A. M.	Hour P. M.	Sine.	Diff.	Cosecant.	Tangent.	Diff.	Cotangent.	Secant.	Diff.	Cosine.	M.
0	10 16 0	1 44 0	9.35209	0	10.64791	9.36336	0	10.63664	10.01128	0	9.98872	60
1	15 52	44 8	35263	1	64737	36394	1	63606	01131	0	98869	59
2	15 44	44 16	35318	2	64682	36452	2	63548	01133	0	98867	58
3	15 36	44 24	35373	3	64627	36509	3	63491	01136	0	98864	57
4	15 28	44 32	35427	4	64573	36566	4	63434	01139	0	98861	56
5	10 15 20	1 44 40	9.35481	4	10.64519	9.36624	5	10.63376	10.01142	0	9.98858	55
6	15 12	44 48	35536	5	64464	36681	6	63319	01145	0	98855	54
7	15 4	44 56	35590	6	64410	36738	6	63262	01148	0	98852	53
8	14 56	45 4	35644	7	64356	36795	7	63205	01151	0	98849	52
9	14 48	45 12	35698	8	64302	36852	8	63148	01154	0	98846	51
10	10 14 40	1 45 20	9.35752	9	10.64248	9.36909	9	10.63091	10.01157	1	9.98843	50
11	14 32	45 28	35806	10	64194	36966	10	63034	01160	1	98840	49
12	14 24	45 36	35860	11	64140	37023	11	62977	01163	1	98837	48
13	14 16	45 44	35914	11	64086	37080	12	62920	01166	1	98834	47
14	14 8	45 52	35968	12	64032	37137	13	62863	01169	1	98831	46
15	10 14 0	1 46 0	9.36022	13	10.63978	9.37193	14	10.62807	10.01172	1	9.98828	45
16	13 52	46 8	36075	14	63925	37250	15	62750	01175	1	98825	44
17	13 44	46 16	36129	15	63871	37306	16	62694	01178	1	98822	43
18	13 36	46 24	36182	16	63818	37363	17	62637	01181	1	98819	42
19	13 28	46 32	36236	17	63764	37419	18	62581	01184	1	98816	41
20	10 13 20	1 46 40	9.36289	18	10.63711	9.37476	19	10.62524	10.01187	1	9.98813	40
21	13 12	46 48	36342	18	63658	37532	19	62468	01190	1	98810	39
22	13 4	46 56	36395	19	63605	37588	20	62412	01193	1	98807	38
23	12 56	47 4	36449	20	63551	37644	21	62356	01196	1	98804	37
24	12 48	47 12	36502	21	63498	37700	22	62300	01199	1	98801	36
25	10 12 40	1 47 20	9.36555	22	10.63445	9.37756	23	10.62244	10.01202	1	9.98798	35
26	12 32	47 28	36608	23	63392	37812	24	62188	01205	1	98795	34
27	12 24	47 36	36660	24	63340	37868	25	62132	01208	1	98792	33
28	12 16	47 44	36713	25	63287	37924	26	62076	01211	1	98789	32
29	12 8	47 52	36766	25	63234	37980	27	62020	01214	1	98786	31
30	10 12 0	1 48 0	9.36819	26	10.63181	9.38035	28	10.61965	10.01217	2	9.98783	30
31	11 52	48 8	36871	27	63129	38091	29	61909	01220	2	98780	29
32	11 44	48 16	36924	28	63076	38147	30	61853	01223	2	98777	28
33	11 36	48 24	36976	29	63024	38202	31	61798	01226	2	98774	27
34	11 28	48 32	37028	30	62972	38257	32	61743	01229	2	98771	26
35	10 11 20	1 48 40	9.37081	31	10.62919	9.38313	32	10.61687	10.01232	2	9.98768	25
36	11 12	48 48	37133	32	62867	38368	33	61632	01235	2	98765	24
37	11 4	48 56	37185	32	62815	38423	34	61577	01238	2	98762	23
38	10 56	49 4	37237	33	62763	38479	35	61521	01241	2	98759	22
39	10 48	49 12	37289	34	62711	38534	36	61466	01244	2	98756	21
40	10 10 40	1 49 20	9.37341	35	10.62659	9.38589	37	10.61411	10.01247	2	9.98753	20
41	10 32	49 28	37393	36	62607	38644	38	61356	01250	2	98750	19
42	10 24	49 36	37445	37	62555	38699	39	61301	01254	2	98746	18
43	10 16	49 44	37497	38	62503	38754	40	61246	01257	2	98743	17
44	10 8	49 52	37549	39	62451	38808	41	61192	01260	2	98740	16
45	10 10 0	1 50 0	9.37600	39	10.62400	9.38863	42	10.61137	10.01263	2	9.98737	15
46	9 52	50 8	37652	40	62348	38918	43	61082	01266	2	98734	14
47	9 44	50 16	37703	41	62297	38972	44	61028	01269	2	98731	13
48	9 36	50 24	37755	42	62245	39027	45	60973	01272	2	98728	12
49	9 28	50 32	37806	43	62194	39082	45	60918	01275	2	98725	11
50	10 9 20	1 50 40	9.37858	44	10.62142	9.39136	46	10.60864	10.01278	3	9.98722	10
51	9 12	50 48	37909	45	62091	39190	47	60810	01281	3	98719	9
52	9 4	50 56	37960	46	62040	39245	48	60755	01285	3	98715	8
53	8 56	51 4	38011	47	61989	39299	49	60701	01288	3	98712	7
54	8 48	51 12	38062	47	61938	39353	50	60647	01291	3	98709	6
55	10 8 40	1 51 20	9.38113	48	10.61887	9.39407	51	10.60593	10.01294	3	9.98706	5
56	8 32	51 28	38164	49	61836	39461	52	60539	01297	3	98703	4
57	8 24	51 36	38215	50	61785	39515	53	60485	01300	3	98700	3
58	8 16	51 44	38266	51	61734	39569	54	60431	01303	3	98697	2
59	8 8	51 52	38317	52	61683	39623	55	60377	01306	3	98694	1
60	8 0	52 0	38368	53	61632	39677	56	60323	01310	3	98690	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff.	Secant.	Cotangent.	Diff.	Tangent.	Cosecant.	Diff.	Sine.	M.
103°			A		A	B		B	C		C	76°

Seconds of time		1ˢ	2ˢ	3ˢ	4ˢ	5ˢ	6ˢ	7ˢ
Prop. parts of cols.	A	7	13	20	26	33	39	46
	B	7	14	21	28	35	42	49
	C	0	1	1	2	2	2	3

TABLE 44.

Log. Sines, Tangents, and Secants.

14°			A		A	B		B	C		C	165°
M.	Hour A. M.	Hour P. M.	Sine.	Diff.	Cosecant.	Tangent.	Diff.	Cotangent.	Secant.	Diff.	Cosine.	M.
0	10 8 0	1 52 0	9. 38368	0	10. 61632	9. 39677	0	10. 60323	10. 01310	0	9. 98690	60
1	7 52	52 8	38418	1	61582	39731	1	60269	01313	0	98687	59
2	7 44	52 16	38469	2	61531	39785	2	60215	01316	0	98684	58
3	7 36	52 24	38519	2	61481	39838	3	60162	01319	0	98681	57
4	7 28	52 32	38570	3	61430	39892	3	60108	01322	0	98678	56
5	10 7 20	1 52 40	9. 38620	4	10. 61380	9. 39945	4	10. 60055	10. 01325	0	9. 98675	55
6	7 12	52 48	38670	5	61330	39999	5	60001	01329	0	98671	54
7	7 4	52 56	38721	6	61279	40052	6	59948	01332	0	98668	53
8	6 56	53 4	38771	7	61229	40106	7	59894	01335	0	98665	52
9	6 48	53 12	38821	7	61179	40159	8	59841	01338	0	98662	51
10	10 6 40	1 53 20	9. 38871	8	10. 61129	9. 40212	9	10. 59788	10. 01341	1	9. 98659	50
11	6 32	53 28	38921	9	61079	40266	10	59734	01344	1	98656	49
12	6 24	53 36	38971	10	61029	40319	10	59681	01348	1	98652	48
13	6 16	53 44	39021	11	60979	40372	11	59628	01351	1	98649	47
14	6 8	53 52	39071	11	60929	40425	12	59575	01354	1	98646	46
15	10 6 0	1 54 0	9. 39121	12	10. 60879	9. 40478	13	10. 59522	10. 01357	1	9. 98643	45
16	5 52	54 8	39170	13	60830	40531	14	59469	01360	1	98640	44
17	5 44	54 16	39220	14	60780	40584	15	59416	01364	1	98636	43
18	5 36	54 24	39270	15	60730	40636	16	59364	01367	1	98633	42
19	5 28	54 32	39319	15	60681	40689	17	59311	01370	1	98630	41
20	10 5 20	1 54 40	9. 39369	16	10. 60631	9. 40742	17	10. 59258	10. 01373	1	9. 98627	40
21	5 12	54 48	39418	17	60582	40795	18	59205	01377	1	98623	39
22	5 4	54 56	39467	18	60533	40847	19	59153	01380	1	98620	38
23	4 56	55 4	39517	19	60483	40900	20	59100	01383	1	98617	37
24	4 48	55 12	39566	20	60434	40952	21	59048	01386	1	98614	36
25	10 4 40	1 55 20	9. 39615	20	10. 60385	9. 41005	22	10. 58995	10. 01390	1	9. 98610	35
26	4 32	55 28	39664	21	60336	41057	23	58943	01393	1	98607	34
27	4 24	55 36	39713	22	60287	41109	23	58891	01396	1	98604	33
28	4 16	55 44	39762	23	60238	41161	24	58839	01399	2	98601	32
29	4 8	55 52	39811	24	60189	41214	25	58786	01403	2	98597	31
30	10 4 0	1 56 0	9. 39860	24	10. 60140	9. 41266	26	10. 58734	10. 01406	2	9. 98594	30
31	3 52	56 8	39909	25	60091	41318	27	58682	01409	2	98591	29
32	3 44	56 16	39958	26	60042	41370	28	58630	01412	2	98588	28
33	3 36	56 24	40006	27	59994	41422	29	58578	01416	2	98584	27
34	3 28	56 32	40055	28	59945	41474	30	58526	01419	2	98581	26
35	10 3 20	1 56 40	9. 40103	29	10. 59897	9. 41526	30	10. 58474	01422	2	9. 98578	25
36	3 12	56 48	40152	29	59848	41578	31	58422	01426	2	98574	24
37	3 4	56 56	40200	30	59800	41629	32	58371	01429	2	98571	23
38	2 56	57 4	40249	31	59751	41681	33	58319	01432	2	98568	22
39	2 48	57 12	40297	32	59703	41733	34	58267	01435	2	98565	21
40	10 2 40	1 57 20	9. 40346	33	10. 59654	9. 41784	35	10. 58216	10. 01439	2	9. 98561	20
41	2 32	57 28	40394	33	59606	41836	36	58164	01442	2	98558	19
42	2 24	57 36	40442	34	59558	41887	36	58113	01445	2	98555	18
43	2 16	57 44	40490	35	59510	41939	37	58061	01449	2	98551	17
44	2 8	57 52	40538	36	59462	41990	38	58010	01452	2	98548	16
45	10 2 0	1 58 0	9. 40586	37	10. 59414	9. 42041	39	10. 57959	10. 01455	2	9. 98545	15
46	1 52	58 8	40634	37	59366	42093	40	57907	01459	3	98541	14
47	1 44	58 16	40682	38	59318	42144	41	57856	01462	3	98538	13
48	1 36	58 24	40730	39	59270	42195	42	57805	01465	3	98535	12
49	1 28	58 32	40778	40	59222	42246	43	57754	01469	3	98531	11
50	10 1 20	1 58 40	9. 40825	41	10. 59175	9. 42297	43	10. 57703	10. 01472	3	9. 98528	10
51	1 12	58 48	40873	42	59127	42348	44	57652	01475	3	98525	9
52	1 4	58 56	40921	42	59079	42399	45	57601	01479	3	98521	8
53	0 56	59 4	40968	43	59032	42450	46	57550	01482	3	98518	7
54	0 48	59 12	41016	44	58984	42501	47	57499	01485	3	98515	6
55	10 0 40	1 59 20	9. 41063	45	10. 58937	9. 42552	48	10. 57448	10. 01489	3	9. 98511	5
56	0 32	59 28	41111	46	58889	42603	49	57397	01492	3	98508	4
57	0 24	59 36	41158	46	58842	42653	50	57347	01495	3	98505	3
58	0 16	59 44	41205	47	58795	42704	50	57296	01499	3	98501	2
59	0 8	59 52	41252	48	58748	42755	51	57245	01502	3	98498	1
60	0 0	2 0 0	41300	49	58700	42805	52	57195	01506	3	98494	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff.	Secant.	Cotangent.	Diff.	Tangent.	Cosecant.	Diff.	Sine.	M.
104°			A		A	B		B	C		C	75°

Seconds of time		1s	2s	3s	4s	5s	6s	7s
Prop. parts of cols.	A	6	12	18	24	31	37	43
	B	7	13	20	26	33	39	46
	C	0	1	1	2	2	2	3

TABLE 44.

Log. Sines, Tangents, and Secants.

15°			A		A	B		B	C		C	164°
M.	Hour A. M.	Hour P. M.	Sine.	Diff.	Cosecant.	Tangent.	Diff.	Cotangent.	Secant.	Diff.	Cosine.	M.
0	10 0 0	2 0 0	9.41300	0	10.58700	9.42805	0	10.57195	10.01506	0	9.98494	60
1	9 59 52	0 8	41347	1	58653	42856	1	57144	01509	0	98491	59
2	59 44	0 16	41394	2	58606	42906	2	57094	01512	0	98488	58
3	59 36	0 24	41441	2	58559	42957	2	57043	01516	0	98484	57
4	59 28	0 32	41488	3	58512	43007	3	56993	01519	0	98481	56
5	9 59 20	2 0 40	9.41535	4	10.58465	9.43057	4	10.56943	10.01523	0	9.98477	55
6	59 12	0 48	41582	5	58418	43108	5	56892	01526	0	98474	54
7	59 4	0 56	41628	5	58372	43158	6	56842	01529	0	98471	53
8	58 56	1 4	41675	6	58325	43208	7	56792	01533	0	98467	52
9	58 48	1 12	41722	7	58278	43258	7	56742	01536	1	98464	51
10	9 58 40	2 1 20	9.41768	8	10.58232	9.43308	8	10.56692	10.01540	1	9.98460	50
11	58 32	1 28	41815	8	58185	43358	9	56642	01543	1	98457	49
12	58 24	1 36	41861	9	58139	43408	10	56592	01547	1	98453	48
13	58 16	1 44	41908	10	58092	43458	11	56542	01550	1	98450	47
14	58 8	1 52	41954	11	58046	43508	11	56492	01553	1	98447	46
15	9 58 0	2 2 0	9.42001	11	10.57999	9.43558	12	10.56442	10.01557	1	9.98443	45
16	57 52	2 8	42047	12	57953	43607	13	56393	01560	1	98440	44
17	57 44	2 16	42093	13	57907	43657	14	56343	01564	1	98436	43
18	57 36	2 24	42140	14	57860	43707	15	56293	01567	1	98433	42
19	57 28	2 32	42186	14	57814	43756	16	56244	01571	1	98429	41
20	9 57 20	2 2 40	9.42232	15	10.57768	9.43806	16	10.56194	10.01574	1	9.98426	40
21	57 12	2 48	42278	16	57722	43855	17	56145	01578	1	98422	39
22	57 4	2 56	42324	17	57676	43905	18	56095	01581	1	98419	38
23	56 56	3 4	42370	17	57630	43954	19	56046	01585	1	98415	37
24	56 48	3 12	42416	18	57584	44004	20	55996	01588	1	98412	36
25	9 56 40	2 3 20	9.42461	19	10.57539	9.44053	20	10.55947	10.01591	1	9.98409	35
26	56 32	3 28	42507	20	57493	44102	21	55898	01595	2	98405	34
27	56 24	3 36	42553	21	57447	44151	22	55849	01598	2	98402	33
28	56 16	3 44	42599	21	57401	44201	23	55799	01602	2	98398	32
29	56 8	3 52	42644	22	57356	44250	24	55750	01605	2	98395	31
30	9 56 0	2 4 0	9.42690	23	10.57310	9.44299	25	10.55701	10.01609	2	9.98391	30
31	55 52	4 8	42735	24	57265	44348	25	55652	01612	2	98388	29
32	55 44	4 16	42781	24	57219	44397	26	55603	01616	2	98384	28
33	55 36	4 24	42826	25	57174	44446	27	55554	01619	2	98381	27
34	55 28	4 32	42872	26	57128	44495	28	55505	01623	2	98377	26
35	9 55 20	2 4 40	9.42917	27	10.57083	9.44544	29	10.55456	10.01627	2	9.98373	25
36	55 12	4 48	42962	27	57038	44592	29	55408	01630	2	98370	24
37	55 4	4 56	43008	28	56992	44641	30	55359	01634	2	98366	23
38	54 56	5 4	43053	29	56947	44690	31	55310	01637	2	98363	22
39	54 48	5 12	43098	30	56902	44738	32	55262	01641	2	98359	21
40	9 54 40	2 5 20	9.43143	30	10.56857	9.44787	33	10.55213	10.01644	2	9.98356	20
41	54 32	5 28	43188	31	56812	44836	34	55164	01648	2	98352	19
42	54 24	5 36	43233	32	56767	44884	34	55116	01651	2	98349	18
43	54 16	5 44	43278	33	56722	44933	35	55067	01655	3	98345	17
44	54 8	5 52	43323	33	56677	44981	36	55019	01658	3	98342	16
45	9 54 0	2 6 0	9.43367	34	10.56633	9.45029	37	10.54971	10.01662	3	9.98338	15
46	53 52	6 8	43412	35	56588	45078	38	54922	01666	3	98334	14
47	53 44	6 16	43457	36	56543	45126	38	54874	01669	3	98331	13
48	53 36	6 24	43502	36	56498	45174	39	54826	01673	3	98327	12
49	53 28	6 32	43546	37	56454	45222	40	54778	01676	3	98324	11
50	9 53 20	2 6 40	9.43591	38	10.56409	9.45271	41	10.54729	10.01680	3	9.98320	10
51	53 12	6 48	43635	39	56365	45319	42	54681	01683	3	98317	9
52	53 4	6 56	43680	39	56320	45367	43	54633	01687	3	98313	8
53	52 56	7 4	43724	40	56276	45415	43	54585	01691	3	98309	7
54	52 48	7 12	43769	41	56231	45463	44	54537	01694	3	98306	6
55	9 52 40	2 7 20	9.43813	42	10.56187	9.45511	45	10.54489	10.01698	3	9.98302	5
56	52 32	7 28	43857	43	56143	45559	46	54441	01701	3	98299	4
57	52 24	7 36	43901	43	56099	45606	47	54394	01705	3	98295	3
58	52 16	7 44	~~43946~~	44	56054	45654	47	54346	01709	3	98291	2
59	52 8	7 52	43990	45	56010	45702	48	54298	01712	3	98288	1
60	52 0	8 0	44034	46	55966	45750	49	54250	01716	4	98284	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff.	Secant.	Cotangent.	Diff.	Tangent.	Cosecant.	Diff.	Sine.	M.
105°			A		A	B		B	C		C	74°

Seconds of time		1s	2s	3s	4s	5s	6s	7s
Prop. parts of cols.	A	6	11	17	23	28	34	40
	B	6	12	18	25	31	37	43
	C	0	1	1	2	2	3	3

TABLE 44.

Log. Sines, Tangents, and Secants.

16°			A		A	B		B	C		C	163°
M.	Hour A. M.	Hour P. M.	Sine.	Diff.	Cosecant.	Tangent.	Diff.	Cotangent.	Secant.	Diff.	Cosine.	M.
0	9 52 0	2 8 0	9.44034	0	10.55966	9.45750	0	10.54250	10.01716	0	9.98284	60
1	51 52	8 8	44078	1	55922	45797	1	54203	01719	0	98281	59
2	51 44	8 16	44122	1	55878	45845	2	54155	01723	0	98277	58
3	51 36	8 24	44166	2	55834	45892	2	54108	01727	0	98273	57
4	51 28	8 32	44210	3	55790	45940	3	54060	01730	0	98270	56
5	9 51 20	2 8 40	9.44253	4	10.55747	9.45987	4	10.54013	10.01734	0	9.98266	55
6	51 12	8 48	44297	4	55703	46035	5	53965	01738	0	98262	54
7	51 4	8 56	44341	5	55659	46082	5	53918	01741	0	98259	53
8	50 56	9 4	44385	6	55615	46130	6	53870	01745	0	98255	52
9	50 48	9 12	44428	6	55572	46177	7	53823	01749	1	98251	51
10	9 50 40	2 9 20	9.44472	7	10.55528	9.46224	8	10.53776	10.01752	1	9.98248	50
11	50 32	9 28	44516	8	55484	46271	9	53729	01756	1	98244	49
12	50 24	9 36	44559	9	55441	46319	9	53681	01760	1	98240	48
13	50 16	9 44	44602	9	55398	46366	10	53634	01763	1	98237	47
14	50 8	9 52	44646	10	55354	46413	11	53587	01767	1	98233	46
15	9 50 0	2 10 0	9.44689	11	10.55311	9.46460	12	10.53540	10.01771	1	9.98229	45
16	49 52	10 8	44733	11	55267	46507	12	53493	01774	1	98226	44
17	49 44	10 16	44776	12	55224	46554	13	53446	01778	1	98222	43
18	49 36	10 24	44819	13	55181	46601	14	53399	01782	1	98218	42
19	49 28	10 32	44862	14	55138	46648	15	53352	01785	1	98215	41
20	9 49 20	2 10 40	9.44905	14	10.55095	9.46694	15	10.53306	10.01789	1	9.98211	40
21	49 12	10 48	44948	15	55052	46741	16	53259	01793	1	98207	39
22	49 4	10 56	44992	16	55008	46788	17	53212	01796	1	98204	38
23	48 56	11 4	45035	16	54965	46835	18	53165	01800	1	98200	37
24	48 48	11 12	45077	17	54923	46881	19	53119	01804	1	98196	36
25	9 48 40	2 11 20	9.45120	18	10.54880	9.46928	19	10.53072	10.01808	2	9.98192	35
26	48 32	11 28	45163	18	54837	46975	20	53025	01811	2	98189	34
27	48 24	11 36	45206	19	54794	47021	21	52979	01815	2	98185	33
28	48 16	11 44	45249	20	54751	47068	22	52932	01819	2	98181	32
29	48 8	11 52	45292	21	54708	47114	22	52886	01823	2	98177	31
30	9 48 0	2 12 0	9.45334	21	10.54666	9.47160	23	10.52840	10.01826	2	9.98174	30
31	47 52	12 8	45377	22	54623	47207	24	52793	01830	2	98170	29
32	47 44	12 16	45419	23	54581	47253	25	52747	01834	2	98166	28
33	47 36	12 24	45462	23	54538	47299	26	52701	01838	2	98162	27
34	47 28	12 32	45504	24	54496	47346	26	52654	01841	2	98159	26
35	9 47 20	2 12 40	9.45547	25	10.54453	9.47392	27	10.52608	10.01845	2	9.98155	25
36	47 12	12 48	45589	26	54411	47438	28	52562	01849	2	98151	24
37	47 4	12 56	45632	26	54368	47484	29	52516	01853	2	98147	23
38	46 56	13 4	45674	27	54326	47530	29	52470	01856	2	98144	22
39	46 48	13 12	45716	28	54284	47576	30	52424	01860	2	98140	21
40	9 46 40	2 13 20	9.45758	28	10.54242	9.47622	31	10.52378	10.01864	2	9.98136	20
41	46 32	13 28	45801	29	54199	47668	32	52332	01868	3	98132	19
42	46 24	13 36	45843	30	54157	47714	32	52286	01871	3	98129	18
43	46 16	13 44	45885	31	54115	47760	33	52240	01875	3	98125	17
44	46 8	13 52	45927	31	54073	47806	34	52194	01879	3	98121	16
45	9 46 0	2 14 0	9.45969	32	10.54031	9.47852	35	10.52148	10.01883	3	9.98117	15
46	45 52	14 8	46011	33	53989	47897	36	52103	01887	3	98113	14
47	45 44	14 16	46053	33	53947	47943	36	52057	01890	3	98110	13
48	45 36	14 24	46095	34	53905	47989	37	52011	01894	3	98106	12
49	45 28	14 32	46136	35	53864	48035	38	51965	01898	3	98102	11
50	9 45 20	2 14 40	9.46178	36	10.53822	9.48080	39	10.51920	10.01902	3	9.98098	10
51	45 12	14 48	46220	36	53780	48126	39	51874	01906	3	98094	9
52	45 4	14 56	46262	37	53738	48171	40	51829	01910	3	98090	8
53	44 56	15 4	46303	38	53697	48217	41	51783	01913	3	98087	7
54	44 48	15 12	46345	38	53655	48262	42	51738	01917	3	98083	6
55	9 44 40	2 15 20	9.46386	39	10.53614	9.48307	43	10.51693	10.01921	3	9.98079	5
56	44 32	15 28	46428	40	53572	48353	43	51647	01925	3	98075	4
57	44 24	15 36	46469	41	53531	48398	44	51602	01929	4	98071	3
58	44 16	15 44	46511	41	53489	48443	45	51557	01933	4	98067	2
59	44 8	15 52	46552	42	53448	48489	46	51511	01937	4	98063	1
60	44 0	16 0	46594	43	53406	48534	46	51466	01940	4	98060	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff.	Secant.	Cotangent	Diff.	Tangent.	Cosecant.	Diff.	Sine.	M.
106°			A		A	B		B	C		C	73°

Seconds of time		1s	2s	3s	4s	5s	6s	7s
Prop. parts of cols.	A	5	11	16	21	27	32	37
	B	6	12	17	23	29	35	41
	C	0	1	1	2	2	3	3

TABLE 44.

Log. Sines, Tangents, and Secants.

17°			A		A	B		B	C		C	162°
M.	**Hour A. M.**	**Hour P. M.**	**Sine.**	**Diff.**	**Cosecant.**	**Tangent.**	**Diff.**	**Cotangent.**	**Secant.**	**Diff.**	**Cosine.**	**M.**
0	9 44 0	2 16 0	9.46594	0	10.53406	9.48534	0	10.51466	10.01940	0	9.98060	60
1	43 52	16 8	46635	1	53365	48579	1	51421	01944	0	98056	59
2	43 44	16 16	46676	1	53324	48624	1	51376	01948	0	98052	58
3	43 36	16 24	46717	2	53283	48669	2	51331	01952	0	98048	57
4	43 28	16 32	46758	3	53242	48714	3	51286	01956	0	98044	56
5	9 43 20	2 16 40	9.46800	3	10.53200	9.48759	4	10.51241	10.01960	0	9.98040	55
6	43 12	16 48	46841	4	53159	48804	4	51196	01964	0	98036	54
7	43 4	16 56	46882	5	53118	48849	5	51151	01968	0	98032	53
8	42 56	17 4	46923	5	53077	48894	6	51106	01971	1	98029	52
9	42 48	17 12	46964	6	53036	48939	7	51061	01975	1	98025	51
10	9 42 40	2 17 20	9.47005	7	10.52995	9.48984	7	10.51016	10.01979	1	9.98021	50
11	42 32	17 28	47045	7	52955	49029	8	50971	01983	1	98017	49
12	42 24	17 36	47086	8	52914	49073	9	50927	01987	1	98013	48
13	42 16	17 44	47127	9	52873	49118	10	50882	01991	1	98009	47
14	42 8	17 52	47168	9	52832	49163	10	50837	01995	1	98005	46
15	9 42 0	2 18 0	9.47209	10	10.52791	9.49207	11	10.50793	10.01999	1	9.98001	45
16	41 52	18 8	47249	11	52751	49252	12	50748	02003	1	97997	44
17	41 44	18 16	47290	11	52710	49296	12	50704	02007	1	97993	43
18	41 36	18 24	47330	12	52670	49341	13	50659	02011	1	97989	42
19	41 28	18 32	47371	13	52629	49385	14	50615	02014	1	97986	41
20	9 41 20	2 18 40	9.47411	13	10.52589	9.49430	15	10.50570	10.02018	1	9.97982	40
21	41 12	18 48	47452	14	52548	49474	15	50526	02022	1	97978	39
22	41 4	18 56	47492	15	52508	49519	16	50481	02026	1	97974	38
23	40 56	19 4	47533	15	52467	49563	17	50437	02030	2	97970	37
24	40 48	19 12	47573	16	52427	49607	18	50393	02034	2	97966	36
25	9 40 40	2 19 20	9.47613	17	10.52387	9.49652	18	10.50348	10.02038	2	9.97962	35
26	40 32	19 28	47654	17	52346	49696	19	50304	02042	2	97958	34
27	40 24	19 36	47694	18	52306	49740	20	50260	02046	2	97954	33
28	40 16	19 44	47734	19	52266	49784	21	50216	02050	2	97950	32
29	40 8	19 52	47774	19	52226	49828	21	50172	02054	2	97946	31
30	9 40 0	2 20 0	9.47814	20	10.52186	9.49872	22	10.50128	10.02058	2	9.97942	30
31	39 52	20 8	47854	21	52146	49916	23	50084	02062	2	97938	29
32	39 44	20 16	47894	21	52106	49960	24	50040	02066	2	97934	28
33	39 36	20 24	47934	22	52066	50004	24	49996	02070	2	97930	27
34	39 28	20 32	47974	23	52026	50048	25	49952	02074	2	97926	26
35	9 39 20	2 20 40	9.48014	23	10.51986	9.50092	26	10.49908	10.02078	2	9.97922	25
36	39 12	20 48	48054	24	51946	50136	26	49864	02082	2	97918	24
37	39 4	20 56	48094	25	51906	50180	27	49820	02086	2	97914	23
38	38 56	21 4	48133	25	51867	50223	28	49777	02090	3	97910	22
39	38 48	21 12	48173	26	51827	50267	29	49733	02094	3	97906	21
40	9 38 40	2 21 20	9.48213	27	10.51787	9.50311	29	10.49689	10.02098	3	9.97902	20
41	38 32	21 28	48252	27	51748	50355	30	49645	02102	3	97898	19
42	38 24	21 36	48292	28	51708	50398	31	49602	02106	3	97894	18
43	38 16	21 44	48332	29	51668	50442	32	49558	02110	3	97890	17
44	38 8	21 52	48371	29	51629	50485	32	49515	02114	3	97886	16
45	9 38 0	2 22 0	9.48411	30	10.51589	9.50529	33	10.49471	10.02118	3	9.97882	15
46	37 52	22 8	48450	31	51550	50572	34	49428	02122	3	97878	14
47	37 44	22 16	48490	31	51510	50616	35	49384	02126	3	97874	13
48	37 36	22 24	48529	32	51471	50659	35	49341	02130	3	97870	12
49	37 28	22 32	48568	33	51432	50703	36	49297	02134	3	97866	11
50	9 37 20	2 22 40	9.48607	33	10.51393	9.50746	37	10.49254	10.02139	3	9.97861	10
51	37 12	22 48	48647	34	51353	50789	37	49211	02143	3	97857	9
52	37 4	22 56	48686	35	51314	50833	38	49167	02147	3	97853	8
53	36 56	23 4	48725	35	51275	50876	39	49124	02151	4	97849	7
54	36 48	23 12	48764	36	51236	50919	40	49081	02155	4	97845	6
55	9 36 40	2 23 20	9.48803	37	10.51197	9.50962	40	10.49038	10.02159	4	9.97841	5
56	36 32	23 28	48842	37	51158	51005	41	48995	02163	4	97837	4
57	36 24	23 36	48881	38	51119	51048	42	48952	02167	4	97833	3
58	36 16	23 44	48920	39	51080	51092	43	48908	02171	4	97829	2
59	36 8	23 52	48959	39	51041	51135	43	48865	02175	4	97825	1
60	36 0	24 0	48998	40	51002	51178	44	48822	02179	4	97821	0
M.	**Hour P. M.**	**Hour A. M.**	**Cosine.**	**Diff.**	**Secant.**	**Cotangent.**	**Diff.**	**Tangent.**	**Cosecant.**	**Diff.**	**Sine.**	**M.**
107°			A		A	B		B	C		C	72°

Seconds of time		1s	2s	3s	4s	5s	6s	7s
Prop. parts of cols.	A	5	10	15	20	25	30	35
	B	6	11	17	22	28	33	39
	C	0	1	1	2	2	3	3

TABLE 44.

Log. Sines, Tangents, and Secants.

18°			A		A	B		B	C		C	161°
M.	Hour A. M.	Hour P. M.	Sine.	Diff.	Cosecant.	Tangent.	Diff.	Cotangent.	Secant.	Diff.	Cosine.	M.
0	9 36 0	2 24 0	9.48998	0	10.51002	9.51178	0	10.48822	10.02179	0	9.97821	60
1	35 52	24 8	49037	1	50963	51221	1	48779	02183	0	97817	59
2	35 44	24 16	49076	1	50924	51264	1	48736	02188	0	97812	58
3	35 36	24 24	49115	2	50885	51306	2	48694	02192	0	97808	57
4	35 28	24 32	49153	3	50847	51349	3	48651	02196	0	97804	56
5	9 35 20	2 24 40	9.49192	3	10.50808	9.51392	3	10.48608	10.02200	0	9.97800	55
6	35 12	24 48	49231	4	50769	51435	4	48565	02204	0	97796	54
7	35 4	24 56	49269	4	50731	51478	5	48522	02208	0	97792	53
8	34 56	25 4	49308	5	50692	51520	6	48480	02212	1	97788	52
9	34 48	25 12	49347	6	50653	51563	6	48437	02216	1	97784	51
10	9 34 40	2 25 20	9.49385	6	10.50615	9.51606	7	10.48394	10.02221	1	9.97779	50
11	34 32	25 28	49424	7	50576	51648	8	48352	02225	1	97775	49
12	34 24	25 36	49462	8	50538	51691	8	48309	02229	1	97771	48
13	34 16	25 44	49500	8	50500	51734	9	48266	02233	1	97767	47
14	34 8	25 52	49539	9	50461	51776	10	48224	02237	1	97763	46
15	9 34 0	2 26 0	9.49577	9	10.50423	9.51819	10	10.48181	10.02241	1	9.97759	45
16	33 52	26 8	49615	10	50385	51861	11	48139	02246	1	97754	44
17	33 44	26 16	49654	11	50346	51903	12	48097	02250	1	97750	43
18	33 36	26 24	49692	11	50308	51946	13	48054	02254	1	97746	42
19	33 28	26 32	49730	12	50270	51988	13	48012	02258	1	97742	41
20	9 33 20	2 26 40	9.49768	13	10.50232	9.52031	14	10.47969	10.02262	1	9.97738	40
21	33 12	26 48	49806	13	50194	52073	15	47927	02266	1	97734	39
22	33 4	26 56	49844	14	50156	52115	15	47885	02271	2	97729	38
23	32 56	27 4	49882	14	50118	52157	16	47843	02275	2	97725	37
24	32 48	27 12	49920	15	50080	52200	17	47800	02279	2	97721	36
25	9 32 40	2 27 20	9.49958	16	10.50042	9.52242	17	10.47758	10.02283	2	9.97717	35
26	32 32	27 28	49996	16	50004	52284	18	47716	02287	2	97713	34
27	32 24	27 36	50034	17	49966	52326	19	47674	02292	2	97708	33
28	32 16	27 44	50072	18	49928	52368	20	47632	02296	2	97704	32
29	32 8	27 52	50110	18	49890	52410	20	47590	02300	2	97700	31
30	9 32 0	2 28 0	9.50148	19	10.49852	9.52452	21	10.47548	10.02304	2	9.97696	30
31	31 52	28 8	50185	20	49815	52494	22	47506	02309	2	97691	29
32	31 44	28 16	50223	20	49777	52536	22	47464	02313	2	97687	28
33	31 36	28 24	50261	21	49739	52578	23	47422	02317	2	97683	27
34	31 28	28 32	50298	21	49702	52620	24	47380	02321	2	97679	26
35	9 31 20	2 28 40	9.50336	22	10.49664	9.52661	24	10.47339	10.02326	2	9.97674	25
36	31 12	28 48	50374	23	49626	52703	25	47297	02330	3	97670	24
37	31 4	28 56	50411	23	49589	52745	26	47255	02334	3	97666	23
38	30 56	29 4	50449	24	49551	52787	27	47213	02338	3	97662	22
39	30 48	29 12	50486	25	49514	52829	27	47171	02343	3	97657	21
40	9 30 40	2 29 20	9.50523	25	10.49477	9.52870	28	10.47130	10.02347	3	9.97653	20
41	30 32	29 28	50561	26	49439	52912	29	47088	02351	3	97649	19
42	30 24	29 36	50598	26	49402	52953	29	47047	02355	3	97645	18
43	30 16	29 44	50635	27	49365	52995	30	47005	02360	3	97640	17
44	30 8	29 52	50673	28	49327	53037	31	46963	02364	3	97636	16
45	9 30 0	2 30 0	9.50710	28	10.49290	9.53078	31	10.46922	10.02368	3	9.97632	15
46	29 52	30 8	50747	29	49253	53120	32	46880	02372	3	97628	14
47	29 44	30 16	50784	30	49216	53161	33	46839	02377	3	97623	13
48	29 36	30 24	50821	30	49179	53202	34	46798	02381	3	97619	12
49	29 28	30 32	50858	31	49142	53244	34	46756	02385	3	97615	11
50	9 29 20	2 30 40	9.50896	31	10.49104	9.53285	35	10.46715	10.02390	4	9.97610	10
51	29 12	30 48	50933	32	49067	53327	36	46673	02394	4	97606	9
52	29 4	30 56	50970	33	49030	53368	36	46632	02398	4	97602	8
53	28 56	31 4	51007	33	48993	53409	37	46591	02403	4	97597	7
54	28 48	31 12	51043	34	48957	53450	38	46550	02407	4	97593	6
55	9 28 40	2 31 20	9.51080	35	10.48920	9.53492	38	10.46508	10.02411	4	9.97589	5
56	28 32	31 28	51117	35	48883	53533	39	46467	02416	4	97584	4
57	28 24	31 36	51154	36	48846	53574	40	46426	02420	4	97580	3
58	28 16	31 44	51191	37	48809	53615	41	46385	02424	4	97576	2
59	28 8	31 52	51227	37	48773	53656	41	46344	02429	4	97571	1
60	28 0	32 0	51264	38	48736	53697	42	46303	02433	4	97567	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff.	Secant.	Cotangent.	Diff.	Tangent.	Cosecant.	Diff.	Sine.	M.
108°			A		A	B		B	C		C	71°

Seconds of time		1^s	2^s	3^s	4^s	5^s	6^s	7^s
Prop. parts of cols.	A	5	9	14	19	24	28	33
	B	5	10	16	21	26	31	37
	C	1	1	2	2	3	3	4

TABLE 44.

Log. Sines, Tangents, and Secants.

19°			A		A	B		B	C		C	160°
M.	**Hour A. M.**	**Hour P. M.**	**Sine.**	**Diff.**	**Cosecant.**	**Tangent.**	**Diff.**	**Cotangent.**	**Secant.**	**Diff.**	**Cosine.**	**M.**
0	9 28 0	2 32 0	9.51264	0	10.48736	9.53697	0	10.46303	10.02433	0	9.97567	60
1	27 52	32 8	51301	1	48699	53738	1	46262	02437	0	97563	59
2	27 44	32 16	51338	1	48662	53779	1	46221	02442	0	97558	58
3	27 36	32 24	51374	2	48626	53820	2	46180	02446	0	97554	57
4	27 28	32 32	51411	2	48589	53861	3	46139	02450	0	97550	56
5	9 27 20	2 32 40	9.51447	3	10.48553	9.53902	3	10.46098	10.02455	0	9.97545	55
6	27 12	32 48	51484	4	48516	53943	4	46057	02459	0	97541	54
7	27 4	32 56	51520	4	48480	53984	5	46016	02464	1	97536	53
8	26 56	33 4	51557	5	48443	54025	5	45975	02468	1	97532	52
9	26 48	33 12	51593	5	48407	54065	6	45935	02472	1	97528	51
10	9 26 40	2 33 20	9.51629	6	10.48371	9.54106	7	10.45894	10.02477	1	9.97523	50
11	26 32	33 28	51666	7	48334	54147	7	45853	02481	1	97519	49
12	26 24	33 36	51702	7	48298	54187	8	45813	02485	1	97515	48
13	26 16	33 44	51738	8	48262	54228	9	45772	02490	1	97510	47
14	26 8	33 52	51774	8	48226	54269	9	45731	02494	1	97506	46
15	9 26 0	2 34 0	9.51811	9	10.48189	9.54309	10	10.45691	10.02499	1	9.97501	45
16	25 52	34 8	51847	10	48153	54350	11	45650	02503	1	97497	44
17	25 44	34 16	51883	10	48117	54390	11	45610	02508	1	97492	43
18	25 36	34 24	51919	11	48081	54431	12	45569	02512	1	97488	42
19	25 28	34 32	51955	11	48045	54471	13	45529	02516	1	97484	41
20	9 25 20	2 34 40	9.51991	12	10.48009	9.54512	13	10.45488	10.02521	1	9.97479	40
21	25 12	34 48	52027	12	47973	54552	14	45448	02525	2	97475	39
22	25 4	34 56	52063	13	47937	54593	15	45407	02530	2	97470	38
23	24 56	35 4	52099	14	47901	54633	15	45367	02534	2	97466	37
24	24 48	35 12	52135	14	47865	54673	16	45327	02539	2	97461	36
25	9 24 40	2 35 20	9.52171	15	10.47829	9.54714	17	10.45286	10.02543	2	9.97457	35
26	24 32	35 28	52207	15	47793	54754	17	45246	02547	2	97453	34
27	24 24	35 36	52242	16	47758	54794	18	45206	02552	2	97448	33
28	24 16	35 44	52278	17	47722	54835	19	45165	02556	2	97444	32
29	24 8	35 52	52314	17	47686	54875	19	45125	02561	2	97439	31
30	9 24 0	2 36 0	9.52350	18	10.47650	9.54915	20	10.45085	10.02565	2	9.97435	30
31	23 52	36 8	52385	18	47615	54955	21	45045	02570	2	97430	29
32	23 44	36 16	52421	19	47579	54995	21	45005	02574	2	97426	28
33	23 36	36 24	52456	20	47544	55035	22	44965	02579	2	97421	27
34	23 28	36 32	52492	20	47508	55075	23	44925	02583	3	97417	26
35	9 23 20	2 36 40	9.52527	21	10.47473	9.55115	23	10.44885	10.02588	3	9.97412	25
36	23 12	36 48	52563	21	47437	55155	24	44845	02592	3	97408	24
37	23 4	36 56	52598	22	47402	55195	25	44805	02597	3	97403	23
38	22 56	37 4	52634	23	47366	55235	25	44765	02601	3	97399	22
39	22 48	37 12	52669	23	47331	55275	26	44725	02606	3	97394	21
40	9 22 40	2 37 20	9.52705	24	10.47295	9.55315	27	10.44685	10.02610	3	9.97390	20
41	22 32	37 28	52740	24	47260	55355	27	44645	02615	3	97385	19
42	22 24	37 36	52775	25	47225	55395	28	44605	02619	3	97381	18
43	22 16	37 44	52811	26	47189	55434	29	44566	02624	3	97376	17
44	22 8	37 52	52846	26	47154	55474	29	44526	02628	3	97372	16
45	9 22 0	2 38 0	9.52881	27	10.47119	9.55514	30	10.44486	10.02633	3	9.97367	15
46	21 52	38 8	52916	27	47084	55554	31	44446	02637	3	97363	14
47	21 44	38 16	52951	28	47049	55593	31	44407	02642	3	97358	13
48	21 36	38 24	52986	29	47014	55633	32	44367	02647	4	97353	12
49	21 28	38 32	53021	29	46979	55673	33	44327	02651	4	97349	11
50	9 21 20	2 38 40	9.53056	30	10.46944	9.55712	33	10.44288	10.02656	4	9.97344	10
51	21 12	38 48	53092	30	46908	55752	34	44248	02660	4	97340	9
52	21 4	38 56	53126	31	46874	55791	35	44209	02665	4	97335	8
53	20 56	39 4	53161	32	46839	55831	35	44169	02669	4	97331	7
54	20 48	39 12	53196	32	46804	55870	36	44130	02674	4	97326	6
55	9 20 40	2 39 20	9.53231	33	10.46769	9.55910	37	10.44090	10.02678	4	9.97322	5
56	20 32	39 28	53266	33	46734	55949	37	44051	02683	4	97317	4
57	20 24	39 36	53301	34	46699	55989	38	44011	02688	4	97312	3
58	20 16	39 44	53336	34	46664	56028	39	43972	02692	4	97308	2
59	20 8	39 52	53370	35	46630	56067	39	43933	02697	4	97303	1
60	20 0	40 0	53405	36	46595	56107	40	43893	02701	4	97299	0
M.	**Hour P. M.**	**Hour A. M.**	**Cosine.**	**Diff.**	**Secant.**	**Cotangent.**	**Diff.**	**Tangent.**	**Cosecant.**	**Diff.**	**Sine.**	**M.**
109°			A		A	B		B	C		C	70°

Seconds of time........		1ˢ	2ˢ	3ˢ	4ˢ	5ˢ	6ˢ	7ˢ
Prop. parts of cols.	A	4	9	13	18	22	27	31
	B	5	10	15	20	25	30	35
	C	1	1	2	2	3	3	4

TABLE 44.

Log. Sines, Tangents, and Secants.

20°			A		A	B		B	C		C	159°
M.	Hour A. M.	Hour P. M.	Sine.	Diff.	Cosecant.	Tangent.	Diff.	Cotangent.	Secant.	Diff.	Cosine.	M.
0	9 20 0	2 40 0	9.53405	0	10.46595	9.56107	0	10.43893	10.02701	0	9.97299	60
1	19 52	40 8	53440	1	46560	56146	1	43854	02706	0	97294	59
2	19 44	40 16	53475	1	46525	56185	1	43815	02711	0	97289	58
3	19 36	40 24	53509	2	46491	56224	2	43776	02715	0	97285	57
4	19 28	40 32	53544	2	46456	56264	3	43736	02720	0	97280	56
5	9 19 20	2 40 40	9.53578	3	10.46422	9.56303	3	10.43697	10.02724	0	9.97276	55
6	19 12	40 48	53613	3	46387	56342	4	43658	02729	0	97271	54
7	19 4	40 56	53647	4	46353	56381	4	43619	02734	1	97266	53
8	18 56	41 4	53682	5	46318	56420	5	43580	02738	1	97262	52
9	18 48	41 12	53716	5	46284	56459	6	43541	02743	1	97257	51
10	9 18 40	2 41 20	9.53751	6	10.46249	9.56498	6	10.43502	10.02748	1	9.97252	50
11	18 32	41 28	53785	6	46215	56537	7	43463	02752	1	97248	49
12	18 24	41 36	53819	7	46181	56576	8	43424	02757	1	97243	48
13	18 16	41 44	53854	7	46146	56615	8	43385	02762	1	97238	47
14	18 8	41 52	53888	8	46112	56654	9	43346	02766	1	97234	46
15	9 18 0	2 42 0	9.53922	8	10.46078	9.56693	10	10.43307	10.02771	1	9.97229	45
16	17 52	42 8	53957	9	46043	56732	10	43268	02776	1	97224	44
17	17 44	42 16	53991	10	46009	56771	11	43229	02780	1	97220	43
18	17 36	42 24	54025	10	45975	56810	12	43190	02785	1	97215	42
19	17 28	42 32	54059	11	45941	56849	12	43151	02790	1	97210	41
20	9 17 20	2 42 40	9.54093	11	10.45907	9.56887	13	10.43113	10.02794	2	9.97206	40
21	17 12	42 48	54127	12	45873	56926	13	43074	02799	2	97201	39
22	17 4	42 56	54161	12	45839	56965	14	43035	02804	2	97196	38
23	16 56	43 4	54195	13	45805	57004	15	42996	02808	2	97192	37
24	16 48	43 12	54229	14	45771	57042	15	42958	02813	2	97187	36
25	9 16 40	2 43 20	9.54263	14	10.45737	9.57081	16	10.42919	10.02818	2	9.97182	35
26	16 32	43 28	54297	15	45703	57120	17	42880	02822	2	97178	34
27	16 24	43 36	54331	15	45669	57158	17	42842	02827	2	97173	33
28	16 16	43 44	54365	16	45635	57197	18	42803	02832	2	97168	32
29	16 8	43 52	54399	16	45601	57235	19	42765	02837	2	97163	31
30	9 16 0	2 44 0	9.54433	17	10.45567	9.57274	19	10.42726	10.02841	2	9.97159	30
31	15 52	44 8	54466	17	45534	57312	20	42688	02846	2	97154	29
32	15 44	44 16	54500	18	45500	57351	21	42649	02851	3	97149	28
33	15 36	44 24	54534	19	45466	57389	21	42611	02855	3	97145	27
34	15 28	44 32	54567	19	45433	57428	22	42572	02860	3	97140	26
35	9 15 20	2 44 40	9.54601	20	10.45399	9.57466	22	10.42534	10.02865	3	9.97135	25
36	15 12	44 48	54635	20	45365	57504	23	42496	02870	3	97130	24
37	15 4	44 56	54668	21	45332	57543	24	42457	02874	3	97126	23
38	14 56	45 4	54702	21	45298	57581	24	42419	02879	3	97121	22
39	14 48	45 12	54735	22	45265	57619	25	42381	02884	3	97116	21
40	9 14 40	2 45 20	9.54769	23	10.45231	9.57658	26	10.42342	10.02889	3	9.97111	20
41	14 32	45 28	54802	23	45198	57696	26	42304	02893	3	97107	19
42	14 24	45 36	54836	24	45164	57734	27	42266	02898	3	97102	18
43	14 16	45 44	54869	24	45131	57772	28	42228	02903	3	97097	17
44	14 8	45 52	54903	25	45097	57810	28	42190	02908	3	97092	16
45	9 14 0	2 46 0	9.54936	25	10.45064	9.57849	29	10.42151	10.02913	4	9.97087	15
46	13 52	46 8	54969	26	45031	57887	30	42113	02917	4	97083	14
47	13 44	46 16	55003	26	44997	57925	30	42075	02922	4	97078	13
48	13 36	46 24	55036	27	44964	57963	31	42037	02927	4	97073	12
49	13 28	46 32	55069	28	44931	58001	31	41999	02932	4	97068	11
50	9 13 20	2 46 40	9.55102	28	10.44898	9.58039	32	10.41961	10.02937	4	9.97063	10
51	13 12	46 48	55136	29	44864	58077	33	41923	02941	4	97059	9
52	13 4	46 56	55169	29	44831	58115	33	41885	02946	4	97054	8
53	12 56	47 4	55202	30	44798	58153	34	41847	02951	4	97049	7
54	12 48	47 12	55235	30	44765	58191	35	41809	02956	4	97044	6
55	9 12 40	2 47 20	9.55268	31	10.44732	9.58229	35	10.41771	10.02961	4	9.97039	5
56	12 32	47 28	55301	32	44699	58267	36	41733	02965	4	97035	4
57	12 24	47 36	55334	32	44666	58304	37	41696	02970	4	97030	3
58	12 16	47 44	55367	33	44633	58342	37	41658	02975	5	97025	2
59	12 8	47 52	55400	33	44600	58380	38	41620	02980	5	97020	1
60	12 0	48 0	55433	34	44567	58418	39	41582	02985	5	97015	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff.	Secant.	Cotangent.	Diff.	Tangent.	Cosecant.	Diff.	Sine.	M.
110°			A		A	B		B	C		C	69°

Seconds of time.......		1^s	2^s	3^s	4^s	5^s	6^s	7^s
Prop. parts of cols.	A	4	8	13	17	21	25	30
	B	5	10	14	19	24	29	34
	C	1	1	2	2	3	4	4

TABLE 44.

Log. Sines, Tangents, and Secants.

21°			A		A	B		B	C		C	158°
M.	Hour A. M.	Hour P. M.	Sine.	Diff.	Cosecant.	Tangent.	Diff.	Cotangent.	Secant.	Diff.	Cosine.	M.
0	9 12 0	2 48 0	9. 55433	0	10. 44567	9. 58418	0	10. 41582	10. 02985	0	9. 97015	60
1	11 52	48 8	55466	1	44534	58455	1	41545	02990	0	97010	59
2	11 44	48 16	55499	1	44501	58493	1	41507	02995	0	97005	58
3	11 36	48 24	55532	2	44468	58531	2	41469	02999	0	97001	57
4	11 28	48 32	55564	2	44436	58569	2	41431	03004	0	96996	56
5	9 11 20	2 48 40	9. 55597	3	10. 44403	9. 58606	3	10. 41394	10. 03009	0	9. 96991	55
6	11 12	48 48	55630	3	44370	58644	4	41356	03014	0	96986	54
7	11 4	48 56	55663	4	44337	58681	4	41319	03019	1	96981	53
8	10 56	49 4	55695	4	44305	58719	5	41281	03024	1	96976	52
9	10 48	49 12	55728	5	44272	58757	6	41243	03029	1	96971	51
10	9 10 40	2 49 20	9. 55761	5	10. 44239	9. 58794	6	10. 41206	10. 03034	1	9. 96966	50
11	10 32	49 28	55793	6	44207	58832	7	41168	03038	1	96962	49
12	10 24	49 36	55826	6	44174	58869	7	41131	03043	1	96957	48
13	10 16	49 44	55858	7	44142	58907	8	41093	03048	1	96952	47
14	10 8	49 52	55891	7	44109	58944	9	41056	03053	1	96947	46
15	9 10 0	2 50 0	9. 55923	8	10. 44077	9. 58981	9	10. 41019	10. 03058	1	9. 96942	45
16	9 52	50 8	55956	9	44044	59019	10	40981	03063	1	96937	44
17	9 44	50 16	55988	9	44012	59056	10	40944	03068	1	96932	43
18	9 36	50 24	56021	10	43979	59094	11	40906	03073	1	96927	42
19	9 28	50 32	56053	10	43947	59131	12	40869	03078	2	96922	41
20	9 9 20	2 50 40	9. 56085	11	10. 43915	9. 59168	12	10. 40832	10. 03083	2	9. 96917	40
21	9 12	50 48	56118	11	43882	59205	13	40795	03088	2	96912	39
22	9 4	50 56	56150	12	43850	59243	14	40757	03093	2	96907	38
23	8 56	51 4	56182	12	43818	59280	14	40720	03097	2	96903	37
24	8 48	51 12	56215	13	43785	59317	15	40683	03102	2	96898	36
25	9 8 40	2 51 20	9. 56247	13	10. 43753	9. 59354	15	10. 40646	10. 03107	2	9. 96893	35
26	8 32	51 28	56279	14	43721	59391	16	40609	03112	2	96888	34
27	8 24	51 36	56311	14	43689	59429	17	40571	03117	2	96883	33
28	8 16	51 44	56343	15	43657	59466	17	40534	03122	2	96878	32
29	8 8	51 52	56375	16	43625	59503	18	40497	03127	2	96873	31
30	9 8 0	2 52 0	9. 56408	16	10. 43592	9. 59540	19	10. 40460	10. 03132	2	9. 96868	30
31	7 52	52 8	56440	17	43560	59577	19	40423	03137	3	96863	29
32	7 44	52 16	56472	17	43528	59614	20	40386	03142	3	96858	28
33	7 36	52 24	56504	18	43496	59651	20	40349	03147	3	96853	27
34	7 28	52 32	56536	18	43464	59688	21	40312	03152	3	96848	26
35	9 7 20	2 52 40	9. 56568	19	10. 43432	9. 59725	22	10. 40275	10. 03157	3	9. 96843	25
36	7 12	52 48	56599	19	43401	59762	22	40238	03162	3	96838	24
37	7 4	52 56	56631	20	43369	59799	23	40201	03167	3	96833	23
38	6 56	53 4	56663	20	43337	59835	23	40165	03172	3	96828	22
39	6 48	53 12	56695	21	43305	59872	24	40128	03177	3	96823	21
40	9 6 40	2 53 20	9. 56727	21	10. 43273	9. 59909	25	10. 40091	10. 03182	3	9. 96818	20
41	6 32	53 28	56759	22	43241	59946	25	40054	03187	3	96813	19
42	6 24	53 36	56790	22	43210	59983	26	40017	03192	3	96808	18
43	6 16	53 44	56822	23	43178	60019	27	39981	03197	4	96803	17
44	6 8	53 52	56854	24	43146	60056	27	39944	03202	4	96798	16
45	9 6 0	2 54 0	9. 56886	24	10. 43114	9. 60093	28	10. 39907	10. 03207	4	9. 96793	15
46	5 52	54 8	56917	25	43083	60130	28	39870	03212	4	96788	14
47	5 44	54 16	56949	25	43051	60166	29	39834	03217	4	96783	13
48	5 36	54 24	56980	26	43020	60203	30	39797	03222	4	96778	12
49	5 28	54 32	57012	26	42988	60240	30	39760	03228	4	96772	11
50	9 5 20	2 54 40	9. 57044	27	10. 42956	9. 60276	31	10. 39724	10. 03233	4	9. 96767	10
51	5 12	54 48	57075	27	42925	60313	31	39687	03238	4	96762	9
52	5 4	54 56	57107	28	42893	60349	32	39651	03243	4	96757	8
53	4 56	55 4	57138	28	42862	60386	33	39614	03248	4	96752	7
54	4 48	55 12	57169	29	42831	60422	33	39578	03253	4	96747	6
55	9 4 40	2 55 20	9. 57201	29	10. 42799	9. 60459	34	10. 39541	10. 03258	5	9. 96742	5
56	4 32	55 28	57232	30	42768	60495	35	39505	03263	5	96737	4
57	4 24	55 36	57264	30	42736	60532	35	39468	03268	5	96732	3
58	4 16	55 44	57295	31	42705	60568	36	39432	03273	5	96727	2
59	4 8	55 52	57326	32	42674	60605	36	39395	03278	5	96722	1
60	4 0	56 0	57358	32	42642	60641	37	39359	03283	5	96717	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff.	Secant.	Cotangent.	Diff.	Tangent.	Cosecant.	Diff.	Sine.	M.
111°			A		A	B		B	C		C	68°

Second of time		1s	2s	3s	4s	5s	6s	7s
Prop. parts of cols.	A	4	8	12	16	20	24	28
	B	5	9	14	19	23	28	32
	C	1	1	2	2	3	4	4

TABLE 44.

Log. Sines, Tangents, and Secants.

22°			A		A	B		B	C		C	157°
M.	Hour A. M.	Hour P. M.	Sine.	Diff.	Cosecant.	Tangent.	Diff.	Cotangent.	Secant.	Diff.	Cosine.	M.
0	9 4 0	2 56 0	9.57358	0	10.42642	9.60641	0	10.39359	10.03283	0	9.96717	60
1	3 52	56 8	57389	1	42611	60677	1	39323	03289	0	96711	59
2	3 44	56 16	57420	1	42580	60714	1	39286	03294	0	96706	58
3	3 36	56 24	57451	2	42549	60750	2	39250	03299	0	96701	57
4	3 28	56 32	57482	2	42518	60786	2	39214	03304	0	96696	56
5	9 3 20	2 56 40	9.57514	3	10.42486	9.60823	3	10.39177	10.03309	0	9.96691	55
6	3 12	56 48	57545	3	42455	60859	4	39141	03314	1	96686	54
7	3 4	56 56	57576	4	42424	60895	4	39105	03319	1	96681	53
8	2 56	57 4	57607	4	42393	60931	5	39069	03324	1	96676	52
9	2 48	57 12	57638	5	42362	60967	5	39033	03330	1	96670	51
10	9 2 40	2 57 20	9.57669	5	10.42331	9.61004	6	10.38996	10.03335	1	9.96665	50
11	2 32	57 28	57700	6	42300	61040	7	38960	03340	1	96660	49
12	2 24	57 36	57731	6	42269	61076	7	38924	03345	1	96655	48
13	2 16	57 44	57762	7	42238	61112	8	38888	03350	1	96650	47
14	2 8	57 52	57793	7	42207	61148	8	38852	03355	1	96645	46
15	9 2 0	2 58 0	9.57824	8	10.42176	9.61184	9	10.38816	10.03360	1	9.96640	45
16	1 52	58 8	57855	8	42145	61220	10	38780	03366	1	96634	44
17	1 44	58 16	57885	9	42115	61256	10	38744	03371	1	96629	43
18	1 36	58 24	57916	9	42084	61292	11	38708	03376	2	96624	42
19	1 28	58 32	57947	10	42053	61328	11	38672	03381	2	96619	41
20	9 1 20	2 58 40	9.57978	10	10.42022	9.61364	12	10.38636	10.03386	2	9.96614	40
21	1 12	58 48	58008	11	41992	61400	13	38600	03392	2	96608	39
22	1 4	58 56	58039	11	41961	61436	13	38564	03397	2	96603	38
23	0 56	59 4	58070	12	41930	61472	14	38528	03402	2	96598	37
24	0 48	59 12	58101	12	41899	61508	14	38492	03407	2	96593	36
25	9 0 40	2 59 20	9.58131	13	10.41869	9.61544	15	10.38456	10.03412	2	9.96588	35
26	0 32	59 28	58162	13	41838	61579	15	38421	03418	2	96582	34
27	0 24	59 36	58192	14	41808	61615	16	38385	03423	2	96577	33
28	0 16	59 44	58223	14	41777	61651	17	38349	03428	2	96572	32
29	0 8	59 52	58253	15	41747	61687	17	38313	03433	3	96567	31
30	9 0 0	3 0 0	9.58284	15	10.41716	9.61722	18	10.38278	10.03438	3	9.96562	30
31	8 59 52	0 8	58314	16	41686	61758	18	38242	03444	3	96556	29
32	59 44	0 16	58345	16	41655	61794	19	38206	03449	3	96551	28
33	59 36	0 24	58375	17	41625	61830	20	38170	03454	3	96546	27
34	59 28	0 32	58406	17	41594	61865	20	38135	03459	3	96541	26
35	8 59 20	3 0 40	9.58436	18	10.41564	9.61901	21	10.38099	10.03465	3	9.96535	25
36	59 12	0 48	58467	18	41533	61936	21	38064	03470	3	96530	24
37	59 4	0 56	58497	19	41503	61972	22	38028	03475	3	96525	23
38	58 56	1 4	58527	19	41473	62008	23	37992	03480	3	96520	22
39	58 48	1 12	58557	20	41443	62043	23	37957	03486	3	96514	21
40	8 58 40	3 1 20	9.58588	20	10.41412	9.62079	24	10.37921	10.03491	3	9.96509	20
41	58 32	1 28	58618	21	41382	62114	24	37886	03496	4	96504	19
42	58 24	1 36	58648	21	41352	62150	25	37850	03502	4	96498	18
43	58 16	1 44	58678	22	41322	62185	26	37815	03507	4	96493	17
44	58 8	1 52	58709	22	41291	62221	26	37779	03512	4	96488	16
45	8 58 0	3 2 0	9.58739	23	10.41261	9.62256	27	10.37744	10.03517	4	9.96483	15
46	57 52	2 8	58769	23	41231	62292	27	37708	03523	4	96477	14
47	57 44	2 16	58799	24	41201	62327	28	37673	03528	4	96472	13
48	57 36	2 24	58829	24	41171	62362	29	37638	03533	4	96467	12
49	57 28	2 32	58859	25	41141	62398	29	37602	03539	4	96461	11
50	8 57 20	3 2 40	9.58889	25	10.41111	9.62433	30	10.37567	10.03544	4	9.96456	10
51	57 12	2 48	58919	26	41081	62468	30	37532	03549	4	96451	9
52	57 4	2 56	58949	26	41051	62504	31	37496	03555	5	96445	8
53	56 56	3 4	58979	27	41021	62539	32	37461	03560	5	96440	7
54	56 48	3 12	59009	27	40991	62574	32	37426	03565	5	96435	6
55	8 56 40	3 3 20	9.59039	28	10.40961	9.62609	33	10.37391	10.03571	5	9.96429	5
56	56 32	3 28	59069	28	40931	62645	33	37355	03576	5	96424	4
57	56 24	3 36	59098	29	40902	62680	34	37320	03581	5	96419	3
58	56 16	3 44	59128	29	40872	62715	35	37285	03587	5	96413	2
59	56 8	3 52	59158	30	40842	62750	35	37250	03592	5	96408	1
60	56 0	4 0	59188	31	40812	62785	36	37215	03597	5	96403	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff.	Secant.	Cotangent.	Diff.	Tangent.	Cosecant.	Diff.	Sine.	M.
112°			A		A	B		B	C		C	67°

Seconds of time		1s	2s	3s	4s	5s	6s	7s
Prop. parts of cols.	A	4	8	11	15	19	23	27
	B	4	9	13	18	22	27	31
	C	1	1	2	3	3	4	5

TABLE 44.

Log. Sines, Tangents, and Secants.

23°			A		A	B		B	C		C	156°
M.	Hour A. M.	Hour P. M.	Sine.	Diff.	Cosecant.	Tangent.	Diff.	Cotangent.	Secant.	Diff.	Cosine.	M.
0	8 56 0	3 4 0	9. 59188	0	10. 40812	9. 62785	0	10. 37215	10. 03597	0	9. 96403	60
1	55 52	4 8	59218	0	40782	62820	1	37180	03603	0	96397	59
2	55 44	4 16	59247	1	40753	62855	1	37145	03608	0	96392	58
3	55 36	4 24	59277	1	40723	62890	2	37110	03613	0	96387	57
4	55 28	4 32	59307	2	40693	62926	2	37074	03619	0	96381	56
5	8 55 20	3 4 40	9. 59336	2	10. 40664	9. 62961	3	10. 37039	10. 03624	0	9. 96376	55
6	55 12	4 48	59366	3	40634	62996	3	37004	03630	1	96370	54
7	55 4	4 56	59396	3	40604	63031	4	36969	03635	1	96365	53
8	54 56	5 4	59425	4	40575	63066	5	36934	03640	1	96360	52
9	54 48	5 12	59455	4	40545	63101	5	36899	03646	1	96354	51
10	8 54 40	3 5 20	9. 59484	5	10. 40516	9. 63135	6	10. 36865	10. 03651	1	9. 96349	50
11	54 32	5 28	59514	5	40486	63170	6	36830	03657	1	96343	49
12	54 24	5 36	59543	6	40457	63205	7	36795	03662	1	96338	48
13	54 16	5 44	59573	6	40427	63240	7	36760	03667	1	96333	47
14	54 8	5 52	59602	7	40398	63275	8	36725	03673	1	96327	46
15	8 54 0	3 6 0	9. 59632	7	10. 40368	9. 63310	9	10. 36690	10. 03678	1	9. 96322	45
16	53 52	6 8	59661	8	40339	63345	9	36655	03684	1	96316	44
17	53 44	6 16	59690	8	40310	63379	10	36621	03689	2	96311	43
18	53 36	6 24	59720	9	40280	63414	10	36586	03695	2	96305	42
19	53 28	6 32	59749	9	40251	63449	11	36551	03700	2	96300	41
20	8 53 20	3 6 40	9. 59778	10	10. 40222	9. 63484	12	10. 36516	10. 03706	2	9. 96294	40
21	53 12	6 48	59808	10	40192	63519	12	36481	03711	2	96289	39
22	53 4	6 56	59837	11	40163	63553	13	36447	03716	2	96284	38
23	52 56	7 4	59866	11	40134	63588	13	36412	03722	2	96278	37
24	52 48	7 12	59895	12	40105	63623	14	36377	03727	2	96273	36
25	8 52 40	3 7 20	9. 59924	12	10. 40076	9. 63657	14	10. 36343	10. 03733	2	9. 96267	35
26	52 32	7 28	59954	13	40046	63692	15	36308	03738	2	96262	34
27	52 24	7 36	59983	13	40017	63726	16	36274	03744	2	96256	33
28	52 16	7 44	60012	14	39988	63761	16	36239	03749	3	96251	32
29	52 8	7 52	60041	14	39959	63796	17	36204	03755	3	96245	31
30	8 52 0	3 8 0	9. 60070	15	10. 39930	9. 63830	17	10. 36170	10. 03760	3	9. 96240	30
31	51 52	8 8	60099	15	39901	63865	18	36135	03766	3	96234	29
32	51 44	8 16	60128	15	39872	63899	18	36101	03771	3	96229	28
33	51 36	8 24	60157	16	39843	63934	19	36066	03777	3	96223	27
34	51 28	8 32	60186	16	39814	63968	20	36032	03782	3	96218	26
35	8 51 20	3 8 40	9. 60215	17	10. 39785	9. 64003	20	10. 35997	10. 03788	3	9. 96212	25
36	51 12	8 48	60244	17	39756	64037	21	35963	03793	3	96207	24
37	51 4	8 56	60273	18	39727	64072	21	35928	03799	3	96201	23
38	50 56	9 4	60302	18	39698	64106	22	35894	03804	3	96196	22
39	50 48	9 12	60331	19	39669	64140	22	35860	03810	4	96190	21
40	8 50 40	3 9 20	9. 60359	19	10. 39641	9. 64175	23	10. 35825	10. 03815	4	9. 96185	20
41	50 32	9 28	60388	20	39612	64209	24	35791	03821	4	96179	19
42	50 24	9 36	60417	20	39583	64243	24	35757	03826	4	96174	18
43	50 16	9 44	60446	21	39554	64278	25	35722	03832	4	96168	17
44	50 8	9 52	60474	21	39526	64312	25	35688	03838	4	96162	16
45	8 50 0	3 10 0	9. 60503	22	10. 39497	9. 64346	26	10. 35654	10. 03843	4	9. 96157	15
46	49 52	10 8	60532	22	39468	64381	26	35619	03849	4	96151	14
47	49 44	10 16	60561	23	39439	64415	27	35585	03854	4	96146	13
48	49 36	10 24	60589	23	39411	64449	28	35551	03860	4	96140	12
49	49 28	10 32	60618	24	39382	64483	28	35517	03865	4	96135	11
50	8 49 20	3 10 40	9. 60646	24	10. 39354	9. 64517	29	10. 35483	10. 03871	5	9. 96129	10
51	49 12	10 48	60675	25	39325	64552	29	35448	03877	5	96123	9
52	49 4	10 56	60704	25	39296	64586	30	35414	03882	5	96118	8
53	48 56	11 4	60732	26	39268	64620	31	35380	03888	5	96112	7
54	48 48	11 12	60761	26	39239	64654	31	35346	03893	5	96107	6
55	8 48 40	3 11 20	9. 60789	27	10. 39211	9. 64688	32	10. 35312	10. 03899	5	9. 96101	5
56	48 32	11 28	60818	27	39182	64722	32	35278	03905	5	96095	4
57	48 24	11 36	60846	28	39154	64756	33	35244	03910	5	96090	3
58	48 16	11 44	60875	28	39125	64790	33	35210	03916	5	96084	2
59	48 8	11 52	60903	29	39097	64824	34	35176	03921	5	96079	1
60	48 0	12 0	60931	29	39069	64858	35	35142	03927	6	96073	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff.	Secant.	Cotangent.	Diff.	Tangent.	Cosecant.	Diff.	Sine.	M.
113°			A		A	B		B	C		C	66°

Seconds of time		1ˢ	2ˢ	3ˢ	4ˢ	5ˢ	6ˢ	7ˢ
Prop. parts of cols.	A	4	7	11	15	18	22	25
	B	4	9	13	17	22	26	31
	C	1	1	2	3	3	4	5

TABLE 44.

Log. Sines, Tangents, and Secants.

24°			A		A	B		B	C		C	155°
M.	Hour A. M.	Hour P. M.	Sine.	Diff.	Cosecant.	Tangent.	Diff.	Cotangent.	Secant.	Diff.	Cosine.	M.
0	8 48 0	3 12 0	9.60931	0	10.39069	9.64858	0	10.35142	10.03927	0	9.96073	60
1	47 52	12 8	60960	0	39040	64892	1	35108	03933	0	96067	59
2	47 44	12 16	60988	1	39012	64926	1	35074	03938	0	96062	58
3	47 36	12 24	61016	1	38984	64960	2	35040	03944	0	96056	57
4	47 28	12 32	61045	2	38955	64994	2	35006	03950	0	96050	56
5	8 47 20	3 12 40	9.61073	2	10.38927	9.65028	3	10.34972	10.03955	0	9.96045	55
6	47 12	12 48	61101	3	38899	65062	3	34938	03961	1	96039	54
7	47 4	12 56	61129	3	38871	65096	4	34904	03966	1	96034	53
8	46 56	13 4	61158	4	38842	65130	4	34870	03972	1	96028	52
9	46 48	13 12	61186	4	38814	65164	5	34836	03978	1	96022	51
10	8 46 40	3 13 20	9.61214	5	10.38786	9.65197	6	10.34803	10.03983	1	9.96017	50
11	46 32	13 28	61242	5	38758	65231	6	34769	03989	1	96011	49
12	46 24	13 36	61270	6	38730	65265	7	34735	03995	1	96005	48
13	46 16	13 44	61298	6	38702	65299	7	34701	04000	1	96000	47
14	46 8	13 52	61326	6	38674	65333	8	34667	04006	1	95994	46
15	8 46 0	3 14 0	9.61354	7	10.38646	9.65366	8	10.34634	10.04012	1	9.95988	45
16	45 52	14 8	61382	7	38618	65400	9	34600	04018	2	95982	44
17	45 44	14 16	61411	8	38589	65434	9	34566	04023	2	95977	43
18	45 36	14 24	61438	8	38562	65467	10	34533	04029	2	95971	42
19	45 28	14 32	61466	9	38534	65501	11	34499	04035	2	95965	41
20	8 45 20	3 14 40	9.61494	9	10.38506	9.65535	11	10.34465	10.04040	2	9.95960	40
21	45 12	14 48	61522	10	38478	65568	12	34432	04046	2	95954	39
22	45 4	14 56	61550	10	38450	65602	12	34398	04052	2	95948	38
23	44 56	15 4	61578	11	38422	65636	13	34364	04058	2	95942	37
24	44 48	15 12	61606	11	38394	65669	13	34331	04063	2	95937	36
25	8 44 40	3 15 20	9.61634	12	10.38366	9.65703	14	10.34297	10.04069	2	9.95931	35
26	44 32	15 28	61662	12	38338	65736	15	34264	04075	2	95925	34
27	44 24	15 36	61689	12	38311	65770	15	34230	04080	3	95920	33
28	44 16	15 44	61717	13	38283	65803	16	34197	04086	3	95914	32
29	44 8	15 52	61745	13	38255	65837	16	34163	04092	3	95908	31
30	8 44 0	3 16 0	9.61773	14	10.38227	9.65870	17	10.34130	10.04098	3	9.95902	30
31	43 52	16 8	61800	14	38200	65904	17	34096	04103	3	95897	29
32	43 44	16 16	61828	15	38172	65937	18	34063	04109	3	95891	28
33	43 36	16 24	61856	15	38144	65971	18	34029	04115	3	95885	27
34	43 28	16 32	61883	16	38117	66004	19	33996	04121	3	95879	26
35	8 43 20	3 16 40	9.61911	16	10.38089	9.66038	20	10.33962	10.04127	3	9.95873	25
36	43 12	16 48	61939	17	38061	66071	20	33929	04132	3	95868	24
37	43 4	16 56	61966	17	38034	66104	21	33896	04138	4	95862	23
38	42 56	17 4	61994	18	38006	66138	21	33862	04144	4	95856	22
39	42 48	17 12	62021	18	37979	66171	22	33829	04150	4	95850	21
40	8 42 40	3 17 20	9.62049	18	10.37951	9.66204	22	10.33796	10.04156	4	9.95844	20
41	42 32	17 28	62076	19	37924	66238	23	33762	04161	4	95839	19
42	42 24	17 36	62104	19	37896	66271	23	33729	04167	4	95833	18
43	42 16	17 44	62131	20	37869	66304	24	33696	04173	4	95827	17
44	42 8	17 52	62159	20	37841	66337	25	33663	04179	4	95821	16
45	8 42 0	3 18 0	9.62186	21	10.37814	9.66371	25	10.33629	10.04185	4	9.95815	15
46	41 52	18 8	62214	21	37786	66404	26	33596	04190	4	95810	14
47	41 44	18 16	62241	22	37759	66437	26	33563	04196	5	95804	13
48	41 36	18 24	62268	22	37732	66470	27	33530	04202	5	95798	12
49	41 28	18 32	62296	23	37704	66503	27	33497	04208	5	95792	11
50	8 41 20	3 18 40	9.62323	23	10.37677	9.66537	28	10.33463	10.04214	5	9.95786	10
51	41 12	18 48	62350	24	37650	66570	28	33430	04220	5	95780	9
52	41 4	18 56	62377	24	37623	66603	29	33397	04225	5	95775	8
53	40 56	19 4	62405	24	37595	66636	30	33364	04231	5	95769	7
54	40 48	19 12	62432	25	37568	66669	30	33331	04237	5	95763	6
55	8 40 40	3 19 20	9.62459	25	10.37541	9.66702	31	10.33298	10.04243	5	9.95757	5
56	40 32	19 28	62486	26	37514	66735	31	33265	04249	5	95751	4
57	40 24	19 36	62513	26	37487	66768	32	33232	04255	5	95745	3
58	40 16	19 44	62541	27	37459	66801	32	33199	04261	6	95739	2
59	40 8	19 52	62568	27	37432	66834	33	33166	04267	6	95733	1
60	40 0	20 0	62595	28	37405	66867	33	33133	04272	6	95728	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff.	Secant.	Cotangent.	Diff.	Tangent.	Cosecant.	Diff.	Sine.	M.
114°			A		A	B		B	C		C	65°

Seconds of time........		1s	2s	3s	4s	5s	6s	7s
Prop. parts of cols.	A	3	7	10	14	17	21	24
	B	4	8	13	17	21	25	29
	C	1	1	2	3	4	4	5

TABLE 44.

Log. Sines, Tangents, and Secants.

25°			A		A	B		B	C		C	154°
M.	Hour A. M.	Hour P. M.	Sine.	Diff.	Cosecant.	Tangent.	Diff.	Cotangent.	Secant.	Diff.	Cosine.	M.
0	8 40 0	3 20 0	9. 62595	0	10. 37405	9. 66867	0	10. 33133	10. 04272	0	9. 95728	60
1	39 52	20 8	62622	0	37378	66900	1	33100	04278	0	95722	59
2	39 44	20 16	62649	1	37351	66933	1	33067	04284	0	95716	58
3	39 36	20 24	62676	1	37324	66966	2	33034	04290	0	95710	57
4	39 28	20 32	62703	2	37297	66999	2	33001	04296	0	95704	56
5	8 39 20	3 20 40	9. 62730	2	10. 37270	9. 67032	3	10. 32968	10. 04302	1	9. 95698	55
6	39 12	20 48	62757	3	37243	67065	3	32935	04308	1	95692	54
7	39 4	20 56	62784	3	37216	67098	4	32902	04314	1	95686	53
8	38 56	21 4	62811	4	37189	67131	4	32869	04320	1	95680	52
9	38 48	21 12	62838	4	37162	67163	5	32837	04326	1	95674	51
10	8 38 40	3 21 20	9. 62865	4	10. 37135	9. 67196	5	10. 32804	10. 04332	1	9. 95668	50
11	38 32	21 28	62892	5	37108	67229	6	32771	04337	1	95663	49
12	38 24	21 36	62918	5	37082	67262	7	32738	04343	1	95657	48
13	38 16	21 44	62945	6	37055	67295	7	32705	04349	1	95651	47
14	38 8	21 52	62972	6	37028	67327	8	32673	04355	1	95645	46
15	8 38 0	3 22 0	9. 62999	7	10. 37001	9. 67360	8	10. 32640	10. 04361	2	9. 95639	45
16	37 52	22 8	63026	7	36974	67393	9	32607	04367	2	95633	44
17	37 44	22 16	63052	8	36948	67426	9	32574	04373	2	95627	43
18	37 36	22 24	63079	8	36921	67458	10	32542	04379	2	95621	42
19	37 28	22 32	63106	8	36894	67491	10	32509	04385	2	95615	41
20	8 37 20	3 22 40	9. 63133	9	10. 36867	9. 67524	11	10. 32476	10. 04391	2	9. 95609	40
21	37 12	22 48	63159	9	36841	67556	11	32444	04397	2	95603	39
22	37 4	22 56	63186	10	36814	67589	12	32411	04403	2	95597	38
23	36 56	23 4	63213	10	36787	67622	12	32378	04409	2	95591	37
24	36 48	23 12	63239	11	36761	67654	13	32346	04415	2	95585	36
25	8 36 40	3 23 20	9. 63266	11	10. 36734	9. 67687	14	10. 32313	10. 04421	3	9. 95579	35
26	36 32	23 28	63292	11	36708	67719	14	32281	04427	3	95573	34
27	36 24	23 36	63319	12	36681	67752	15	32248	04433	3	95567	33
28	36 16	23 44	63345	12	36655	67785	15	32215	04439	3	95561	32
29	36 8	23 52	63372	13	36628	67817	16	32183	04445	3	95555	31
30	8 36 0	3 24 0	9. 63398	13	10. 36602	9. 67850	16	10. 32150	10. 04451	3	9. 95549	30
31	35 52	24 8	63425	14	36575	67882	17	32118	04457	3	95543	29
32	35 44	24 16	63451	14	36549	67915	17	32085	04463	3	95537	28
33	35 36	24 24	63478	15	36522	67947	18	32053	04469	3	95531	27
34	35 28	24 32	63504	15	36496	67980	18	32020	04475	3	95525	26
35	8 35 20	3 24 40	9. 63531	15	10. 36469	9. 68012	19	10. 31988	10. 04481	4	9. 95519	25
36	35 12	24 48	63557	16	36443	68044	20	31956	04487	4	95513	24
37	35 4	24 56	63583	16	36417	68077	20	31923	04493	4	95507	23
38	34 56	25 4	63610	17	36390	68109	21	31891	04500	4	95500	22
39	34 48	25 12	63636	17	36364	68142	21	31858	04506	4	95494	21
40	8 34 40	3 25 20	9. 63662	18	10. 36338	9. 68174	22	10. 31826	10. 04512	4	9. 95488	20
41	34 32	25 28	63689	18	36311	68206	22	31794	04518	4	95482	19
42	34 24	25 36	63715	19	36285	68239	23	31761	04524	4	95476	18
43	34 16	25 44	63741	19	36259	68271	23	31729	04530	4	95470	17
44	34 8	25 52	63767	19	36233	68303	24	31697	04536	4	95464	16
45	8 34 0	3 26 0	9. 63794	20	10. 36206	9. 68336	24	10. 31664	10. 04542	5	9. 95458	15
46	33 52	26 8	63820	20	36180	68368	25	31632	04548	5	95452	14
47	33 44	26 16	63846	21	36154	68400	25	31600	04554	5	95446	13
48	33 36	26 24	63872	21	36128	68432	26	31568	04560	5	95440	12
49	33 28	26 32	63898	22	36102	68465	27	31535	04566	5	95434	11
50	8 33 20	3 26 40	9. 63924	22	10. 36076	9. 68497	27	10. 31503	10. 04573	5	9. 95427	10
51	33 12	26 48	63950	23	36050	68529	28	31471	04579	5	95421	9
52	33 4	26 56	63976	23	36024	68561	28	31439	04585	5	95415	8
53	32 56	27 4	64002	23	35998	68593	29	31407	04591	5	95409	7
54	32 48	27 12	64028	24	35972	68626	29	31374	04597	5	95403	6
55	8 32 40	3 27 20	9. 64054	24	10. 35946	9. 68658	30	10. 31342	10. 04603	6	9. 95397	5
56	32 32	27 28	64080	25	35920	68690	30	31310	04609	6	95391	4
57	32 24	27 36	64106	25	35894	68722	31	31278	04616	6	95384	3
58	32 16	27 44	64132	26	35868	68754	31	31246	04622	6	95378	2
59	32 8	27 52	64158	26	35842	68786	32	31214	04628	6	95372	1
60	32 0	28 0	64184	26	35816	68818	33	31182	04634	6	95366	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff.	Secant.	Cotangent.	Diff.	Tangent.	Cosecant.	Diff.	Sine.	M.
115°			A		A	B		B	C		C	64°

Seconds of time.......		1ˢ	2ˢ	3ˢ	4ˢ	5ˢ	6ˢ	7ˢ
Prop. parts of cols.	A	3	7	10	13	17	20	23
	B	4	8	12	16	20	24	28
	C	1	2	2	3	4	5	5

TABLE 44.

Log. Sines, Tangents, and Secants.

26°			A		A	B		B	C		C	153°
M.	Hour A. M.	Hour P. M.	Sine.	Diff.	Cosecant.	Tangent.	Diff.	Cotangent.	Secant.	Diff.	Cosine.	M.
0	8 32 0	3 28 0	9. 64184	0	10. 35816	9. 68818	0	10. 31182	10. 04634	0	9. 95366	60
1	31 52	28 8	64210	0	35790	68850	1	31150	04640	0	95360	59
2	31 44	28 16	64236	1	35764	68882	1	31118	04646	0	95354	58
3	31 36	28 24	64262	1	35738	68914	2	31086	04652	0	95348	57
4	31 28	28 32	64288	2	35712	68946	2	31054	04659	0	95341	56
5	8 31 20	3 28 40	9. 64313	2	10. 35687	9. 68978	3	10. 31022	10. 04665	1	9. 95335	55
6	31 12	28 48	64339	3	35661	69010	3	30990	04671	1	95329	54
7	31 4	28 56	64365	3	35635	69042	4	30958	04677	1	95323	53
8	30 56	29 4	64391	3	35609	69074	4	30926	04683	1	95317	52
9	30 48	29 12	64417	4	35583	69106	5	30894	04690	1	95310	51
10	8 30 40	3 29 20	9. 64442	4	10. 35558	9. 69138	5	10. 30862	10. 04696	1	9. 95304	50
11	30 32	29 28	64468	5	35532	69170	6	30830	04702	1	95298	49
12	30 24	29 36	64494	5	35506	69202	6	30798	04708	1	95292	48
13	30 16	29 44	64519	5	35481	69234	7	30766	04714	1	95286	47
14	30 8	29 52	64545	6	35455	69266	7	30734	04721	1	95279	46
15	8 30 0	3 30 0	9. 64571	6	10. 35429	9. 69298	8	10. 30702	10. 04727	2	9. 95273	45
16	29 52	30 8	64596	7	35404	69329	8	30671	04733	2	95267	44
17	29 44	30 16	64622	7	35378	69361	9	30639	04739	2	95261	43
18	29 36	30 24	64647	8	35353	69393	9	30607	04746	2	95254	42
19	29 28	30 32	64673	8	35327	69425	10	30575	04752	2	95248	41
20	8 29 20	3 30 40	9. 64698	8	10. 35302	9. 69457	11	10. 30543	10. 04758	2	9. 95242	40
21	29 12	30 48	64724	9	35276	69488	11	30512	04764	2	95236	39
22	29 4	30 56	64749	9	35251	69520	12	30480	04771	2	95229	38
23	28 56	31 4	64775	10	35225	69552	12	30448	04777	2	95223	37
24	28 48	31 12	64800	10	35200	69584	13	30416	04783	3	95217	36
25	8 28 40	3 31 20	9. 64826	11	10. 35174	9. 69615	13	10. 30385	10. 04789	3	9. 95211	35
26	28 32	31 28	64851	11	35149	69647	14	30353	04796	3	95204	34
27	28 24	31 36	64877	11	35123	69679	14	30321	04802	3	95198	33
28	28 16	31 44	64902	12	35098	69710	15	30290	04808	3	95192	32
29	28 8	31 52	64927	12	35073	69742	15	30258	04815	3	95185	31
30	8 28 0	3 32 0	9. 64953	13	10. 35047	9. 69774	16	10. 30226	10. 04821	3	9. 95179	30
31	27 52	32 8	64978	13	35022	69805	16	30195	04827	3	95173	29
32	27 44	32 16	65003	14	34997	69837	17	30163	04833	3	95167	28
33	27 36	32 24	65029	14	34971	69868	17	30132	04840	3	95160	27
34	27 28	32 32	65054	14	34946	69900	18	30100	04846	4	95154	26
35	8 27 20	3 32 40	9. 65079	15	10. 34921	9. 69932	18	10. 30068	10. 04852	4	9. 95148	25
36	27 12	32 48	65104	15	34896	69963	19	30037	04859	4	95141	24
37	27 4	32 56	65130	16	34870	69995	20	30005	04865	4	95135	23
38	26 56	33 4	65155	16	34845	70026	20	29974	04871	4	95129	22
39	26 48	33 12	65180	16	34820	70058	21	29942	04878	4	95122	21
40	8 26 40	3 33 20	9. 65205	17	10. 34795	9. 70089	21	10. 29911	10. 04884	4	9. 95116	20
41	26 32	33 28	65230	17	34770	70121	22	29879	04890	4	95110	19
42	26 24	33 36	65255	18	34745	70152	22	29848	04897	4	95103	18
43	26 16	33 44	65281	18	34719	70184	23	29816	04903	5	95097	17
44	26 8	33 52	65306	19	34694	70215	23	29785	04910	5	95090	16
45	8 26 0	3 34 0	9. 65331	19	10. 34669	9. 70247	24	10. 29753	10. 04916	5	9. 95084	15
46	25 52	34 8	65356	19	34644	70278	24	29722	04922	5	95078	14
47	25 44	34 16	65381	20	34619	70309	25	29691	04929	5	95071	13
48	25 36	34 24	65406	20	34594	70341	25	29659	04935	5	95065	12
49	25 28	34 32	65431	21	34569	70372	26	29628	04941	5	95059	11
50	8 25 20	3 34 40	9. 65456	21	10. 34544	9. 70404	26	10. 29596	10. 04948	5	9. 95052	10
51	25 12	34 48	65481	22	34519	70435	27	29565	04954	5	95046	9
52	25 4	34 56	65506	22	34494	70466	27	29534	04961	5	95039	8
53	24 56	35 4	65531	22	34469	70498	28	29502	04967	6	95033	7
54	24 48	35 12	65556	23	34444	70529	28	29471	04973	6	95027	6
55	8 24 40	3 35 20	9. 65580	23	10. 34420	9. 70560	29	10. 29440	10. 04980	6	9. 95020	5
56	24 32	35 28	65605	24	34395	70592	30	29408	04986	6	95014	4
57	24 24	35 36	65630	24	34370	70623	30	29377	04993	6	95007	3
58	24 16	35 44	65655	25	34345	70654	31	29346	04999	6	95001	2
59	24 8	35 52	65680	25	34320	70685	31	29315	05005	6	94995	1
60	24 0	36 0	65705	25	34295	70717	32	29283	05012	6	94988	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff.	Secant.	Cotangent.	Diff.	Tangent.	Cosecant.	Diff.	Sine.	M.
116°			A		A	B		B	C		C	63°

Seconds of time		1^s	2^s	3^s	4^s	5^s	6^s	7^s
Prop. parts of cols.	A	3	6	10	13	16	19	22
	B	4	8	12	16	20	24	28
	C	1	2	2	3	4	5	6

TABLE 44.

Log. Sines, Tangents, and Secants.

27°			A		A	B		B	C		C	152°
M.	**Hour A. M.**	**Hour P. M.**	**Sine.**	**Diff.**	**Cosecant.**	**Tangent.**	**Diff.**	**Cotangent.**	**Secant.**	**Diff.**	**Cosine.**	**M.**
0	8 24 0	3 36 0	9. 65705	0	10. 34295	9. 70717	0	10. 29283	10. 05012	0	9. 94988	60
1	23 52	36 8	65729	0	34271	70748	1	29252	05018	0	94982	59
2	23 44	36 16	65754	1	34246	70779	1	29221	05025	0	94975	58
3	23 36	36 24	65779	1	34221	70810	2	29190	05031	0	94969	57
4	23 28	36 32	65804	2	34196	70841	2	29159	05038	0	94962	56
5	8 23 20	3 36 40	9. 65828	2	10. 34172	9. 70873	3	10. 29127	10. 05044	1	9. 94956	55
6	23 12	36 48	65853	2	34147	70904	3	29096	05051	1	94949	54
7	23 4	36 56	65878	3	34122	70935	4	29065	05057	1	94943	53
8	22 56	37 4	65902	3	34098	70966	4	29034	05064	1	94936	52
9	22 48	37 12	65927	4	34073	70997	5	29003	05070	1	94930	51
10	8 22 40	3 37 20	9. 65952	4	10. 34048	9. 71028	5	10. 28972	10. 05077	1	9. 94923	50
11	22 32	37 28	65976	4	34024	71059	6	28941	05083	1	94917	49
12	22 24	37 36	66001	5	33999	71090	6	28910	05089	1	94911	48
13	22 16	37 44	66025	5	33975	71121	7	28879	05096	1	94904	47
14	22 8	37 52	66050	6	33950	71153	7	28847	05102	2	94898	46
15	8 22 0	3 38 0	9. 66075	6	10. 33925	9. 71184	8	10. 28816	10. 05109	2	9. 94891	45
16	21 52	38 8	66099	6	33901	71215	8	28785	05115	2	94885	44
17	21 44	38 16	66124	7	33876	71246	9	28754	05122	2	94878	43
18	21 36	38 24	66148	7	33852	71277	9	28723	05129	2	94871	42
19	21 28	38 32	66173	8	33827	71308	10	28692	05135	2	94865	41
20	8 21 20	3 38 40	9. 66197	8	10. 33803	9. 71339	10	10. 28661	10. 05142	2	9. 94858	40
21	21 12	38 48	66221	8	33779	71370	11	28630	05148	2	94852	39
22	21 4	38 56	66246	9	33754	71401	11	28599	05155	2	94845	38
23	20 56	39 4	66270	9	33730	71431	12	28569	05161	3	94839	37
24	20 48	39 12	66295	10	33705	71462	12	28538	05168	3	94832	36
25	8 20 40	3 39 20	9. 66319	10	10. 33681	9. 71493	13	10. 28507	10. 05174	3	9. 94826	35
26	20 32	39 28	66343	11	33657	71524	13	28476	05181	3	94819	34
27	20 24	39 36	66368	11	33632	71555	14	28445	05187	3	94813	33
28	20 16	39 44	66392	11	33608	71586	14	28414	05194	3	94806	32
29	20 8	39 52	66416	12	33584	71617	15	28383	05201	3	94799	31
30	8 20 0	3 40 0	9. 66441	12	10. 33559	9. 71648	15	10. 28352	10. 05207	3	9. 94793	30
31	19 52	40 8	66465	13	33535	71679	16	28321	05214	3	94786	29
32	19 44	40 16	66489	13	33511	71709	16	28291	05220	4	94780	28
33	19 36	40 24	66513	13	33487	71740	17	28260	05227	4	94773	27
34	19 28	40 32	66537	14	33463	71771	17	28229	05233	4	94767	26
35	8 19 20	3 40 40	9. 66562	14	10. 33438	9. 71802	18	10. 28198	10. 05240	4	9. 94760	25
36	19 12	40 48	66586	15	33414	71833	19	28167	05247	4	94753	24
37	19 4	40 56	66610	15	33390	71863	19	28137	05253	4	94747	23
38	18 56	41 4	66634	15	33366	71894	20	28106	05260	4	94740	22
39	18 48	41 12	66658	16	33342	71925	20	28075	05266	4	94734	21
40	8 18 40	3 41 20	9. 66682	16	10. 33318	9. 71955	21	10. 28045	10. 05273	4	9. 94727	20
41	18 32	41 28	66706	17	33294	71986	21	28014	05280	4	94720	19
42	18 24	41 36	66731	17	33269	72017	22	27983	05286	5	94714	18
43	18 16	41 44	66755	17	33245	72048	22	27952	05293	5	94707	17
44	18 8	41 52	66779	18	33221	72078	23	27922	05300	5	94700	16
45	8 18 0	3 42 0	9. 66803	18	10. 33197	9. 72109	23	10. 27891	10. 05306	5	9. 94694	15
46	17 52	42 8	66827	19	33173	72140	24	27860	05313	5	94687	14
47	17 44	42 16	66851	19	33149	72170	24	27830	05320	5	94680	13
48	17 36	42 24	66875	19	33125	72201	25	27799	05326	5	94674	12
49	17 28	42 32	66899	20	33101	72231	25	27769	05333	5	94667	11
50	8 17 20	3 42 40	9. 66922	20	10. 33078	9. 72262	26	10. 27738	10. 05340	5	9. 94660	10
51	17 12	42 48	66946	21	33054	72293	26	27707	05346	6	94654	9
52	17 4	42 56	66970	21	33030	72323	27	27677	05353	6	94647	8
53	16 56	43 4	66994	21	33006	72354	27	27646	05360	6	94640	7
54	16 48	43 12	67018	22	32982	72384	28	27616	05366	6	94634	6
55	8 16 40	3 43 20	9. 67042	22	10. 32958	9. 72415	28	10. 27585	10. 05373	6	9. 94627	5
56	16 32	43 28	67066	23	32934	72445	29	27555	05380	6	94620	4
57	16 24	43 36	67090	23	32910	72476	29	27524	05386	6	94614	3
58	16 16	43 44	67113	23	32887	72506	30	27494	05393	6	94607	2
59	16 8	43 52	67137	24	32863	72537	30	27463	05400	6	94600	1
60	16 0	44 0	67161	24	32839	72567	31	27433	05407	7	94593	0
M.	**Hour P. M.**	**Hour A. M.**	**Cosine.**	**Diff.**	**Secant.**	**Cotangent.**	**Diff.**	**Tangent.**	**Cosecant.**	**Diff.**	**Sine.**	**M.**
117°			A		A	B		B	C		C	62°

Seconds of time		1s	2s	3s	4s	5s	6s	7s
Prop. parts of cols.	A	3	6	9	12	15	18	21
	B	4	8	12	15	19	23	27
	C	1	2	2	3	4	5	6

TABLE 44.

Log. Sines, Tangents, and Secants.

30°			A		A	B		B	C		C	149°
M.	Hour A. M.	Hour P. M.	Sine.	Diff.	Cosecant.	Tangent.	Diff.	Cotangent.	Secant.	Diff.	Cosine.	M.
0	8 0 0	4 0 0	9. 69897	0	10. 30103	9. 76144	0	10. 23856	10. 06247	0	9. 93753	60
1	7 59 52	0 8	69919	0	30081	76173	0	23827	06254	0	93746	59
2	59 44	0 16	69941	1	30059	76202	1	23798	06262	0	93738	58
3	59 36	0 24	69963	1	30037	76231	1	23769	06269	0	93731	57
4	59 28	0 32	69984	1	30016	76261	2	23739	06276	0	93724	56
5	7 59 20	4 0 40	9. 70006	2	10. 29994	9. 76290	2	10. 23710	10. 06283	1	9. 93717	55
6	59 12	0 48	70028	2	29972	76319	3	23681	06291	1	93709	54
7	59 4	0 56	70050	3	29950	76348	3	23652	06298	1	93702	53
8	58 56	1 4	70072	3	29928	76377	4	23623	06305	1	93695	52
9	58 48	1 12	70093	3	29907	76406	4	23594	06313	1	93687	51
10	7 58 40	4 1 20	9. 70115	4	10. 29885	9. 76435	5	10. 23565	10. 06320	1	9. 93680	50
11	58 32	1 28	70137	4	29863	76464	5	23536	06327	1	93673	49
12	58 24	1 36	70159	4	29841	76493	6	23507	06335	1	93665	48
13	58 16	1 44	70180	5	29820	76522	6	23478	06342	2	93658	47
14	58 8	1 52	70202	5	29798	76551	7	23449	06350	2	93650	46
15	7 58 0	4 2 0	9. 70224	5	10. 29776	9. 76580	7	10. 23420	10. 06357	2	9. 93643	45
16	57 52	2 8	70245	6	29755	76609	8	23391	06364	2	93636	44
17	57 44	2 16	70267	6	29733	76639	8	23361	06372	2	93628	43
18	57 36	2 24	70288	6	29712	76668	9	23332	06379	2	93621	42
19	57 28	2 32	70310	7	29690	76697	9	23303	06386	2	93614	41
20	7 57 20	4 2 40	9. 70332	7	10. 29668	9. 76725	10	10. 23275	10. 06394	2	9. 93606	40
21	57 12	2 48	70353	8	29647	76754	10	23246	06401	3	93599	39
22	57 4	2 56	70375	8	29625	76783	11	23217	06409	3	93591	38
23	56 56	3 4	70396	8	29604	76812	11	23188	06416	3	93584	37
24	56 48	3 12	70418	9	29582	76841	12	23159	06423	3	93577	36
25	7 56 40	4 3 20	9. 70439	9	10. 29561	9. 76870	12	10. 23130	10. 06431	3	9. 93569	35
26	56 32	3 28	70461	9	29539	76899	13	23101	06438	3	93562	34
27	56 24	3 36	70482	10	29518	76928	13	23072	06446	3	93554	33
28	56 16	3 44	70504	10	29496	76957	13	23043	06453	3	93547	32
29	56 8	3 52	70525	10	29475	76986	14	23014	06461	4	93539	31
30	7 56 0	4 4 0	9. 70547	11	10. 29453	9. 77015	14	10. 22985	10. 06468	4	9. 93532	30
31	55 52	4 8	70568	11	29432	77044	15	22956	06475	4	93525	29
32	55 44	4 16	70590	11	29410	77073	15	22927	06483	4	93517	28
33	55 36	4 24	70611	12	29389	77101	16	22899	06490	4	93510	27
34	55 28	4 32	70633	12	29367	77130	16	22870	06498	4	93502	26
35	7 55 20	4 4 40	9. 70654	13	10. 29346	9. 77159	17	10. 22841	10. 06505	4	9. 93495	25
36	55 12	4 48	70675	13	29325	77188	17	22812	06513	4	93487	24
37	55 4	4 56	70697	13	29303	77217	18	22783	06520	5	93480	23
38	54 56	5 4	70718	14	29282	77246	18	22754	06528	5	93472	22
39	54 48	5 12	70739	14	29261	77274	19	22726	06535	5	93465	21
40	7 54 40	4 5 20	9. 70761	14	10. 29239	9. 77303	19	10. 22697	10. 06543	5	9. 93457	20
41	54 32	5 28	70782	15	29218	77332	20	22668	06550	5	93450	19
42	54 24	5 36	70803	15	29197	77361	20	22639	06558	5	93442	18
43	54 16	5 44	70824	15	29176	77390	21	22610	06565	5	93435	17
44	54 8	5 52	70846	16	29154	77418	21	22582	06573	5	93427	16
45	7 54 0	4 6 0	9. 70867	16	10. 29133	9. 77447	22	10. 22553	10. 06580	6	9. 93420	15
46	53 52	6 8	70888	16	29112	77476	22	22524	06588	6	93412	14
47	53 44	6 16	70909	17	29091	77505	23	22495	06595	6	93405	13
48	53 36	6 24	70931	17	29069	77533	23	22467	06603	6	93397	12
49	53 28	6 32	70952	18	29048	77562	24	22438	06610	6	93390	11
50	7 53 20	4 6 40	9. 70973	18	10. 29027	9. 77591	24	10. 22409	10. 06618	6	9. 93382	10
51	53 12	6 48	70994	18	29006	77619	25	22381	06625	6	93375	9
52	53 4	6 56	71015	19	28985	77648	25	22352	06633	6	93367	8
53	52 56	7 4	71036	19	28964	77677	26	22323	06640	7	93360	7
54	52 48	7 12	71058	19	28942	77706	26	22294	06648	7	93352	6
55	7 52 40	4 7 20	9. 71079	20	10. 28921	9. 77734	26	10. 22266	10. 06656	7	9. 93344	5
56	52 32	7 28	71100	20	28900	77763	27	22237	06663	7	93337	4
57	52 24	7 36	71121	20	28879	77791	27	22209	06671	7	93329	3
58	52 16	7 44	71142	21	28858	77820	28	22180	06678	7	93322	2
59	52 8	7 52	71163	21	28837	77849	28	22151	06686	7	93314	1
60	52 0	8 0	71184	21	28816	77877	29	22123	06693	7	93307	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff.	Secant.	Cotangent.	Diff.	Tangent.	Cosecant.	Diff.	Sine.	M.
120°			A		A	B		B	C		C	59°

Seconds of time		1ˢ	2ˢ	3ˢ	4ˢ	5ˢ	6ˢ	7ˢ
Prop. parts of cols.	A	3	5	8	11	13	16	19
	B	4	7	11	14	18	22	25
	C	1	2	3	4	5	6	7

TABLE 44.

Log. Sines, Tangents, and Secants.

31°			A		A	B		B	C		C	148°
M.	Hour A. M.	Hour P. M.	Sine.	Diff.	Cosecant.	Tangent.	Diff.	Cotangent.	Secant.	Diff.	Cosine.	M.
0	7 52 0	4 8 0	9. 71184	0	10. 28816	9. 77877	0	10. 22123	10. 06693	0	9. 93307	60
1	51 52	8 8	71205	0	28795	77906	0	22094	06701	0	93299	59
2	51 44	8 16	71226	1	28774	77935	1	22065	06709	0	93291	58
3	51 36	8 24	71247	1	28753	77963	1	22037	06716	0	93284	57
4	51 28	8 32	71268	1	28732	77992	2	22008	06724	1	93276	56
5	7 51 20	4 8 40	9. 71289	2	10. 28711	9. 78020	2	10. 21980	10. 06731	1	9. 93269	55
6	51 12	8 48	71310	2	28690	78049	3	21951	06739	1	93261	54
7	51 4	8 56	71331	2	28669	78077	3	21923	06747	1	93253	53
8	50 56	9 4	71352	3	28648	78106	4	21894	06754	1	93246	52
9	50 48	9 12	71373	3	28627	78135	4	21865	06762	1	93238	51
10	7 50 40	4 9 20	9. 71393	3	10. 28607	9. 78163	5	10. 21837	10. 06770	1	9. 93230	50
11	50 32	9 28	71414	4	28586	78192	5	21808	06777	1	93223	49
12	50 24	9 36	71435	4	28565	78220	6	21780	06785	2	93215	48
13	50 16	9 44	71456	4	28544	78249	6	21751	06793	2	93207	47
14	50 8	9 52	71477	5	28523	78277	7	21723	06800	2	93200	46
15	7 50 0	4 10 0	9. 71498	5	10. 28502	9. 78306	7	10. 21694	10. 06808	2	9. 93192	45
16	49 52	10 8	71519	5	28481	78334	8	21666	06816	2	93184	44
17	49 44	10 16	71539	6	28461	78363	8	21637	06823	2	93177	43
18	49 36	10 24	71560	6	28440	78391	9	21609	06831	2	93169	42
19	49 28	10 32	71581	7	28419	78419	9	21581	06839	2	93161	41
20	7 49 20	4 10 40	9. 71602	7	10. 28398	9. 78448	9	10. 21552	10. 06846	3	9. 93154	40
21	49 12	10 48	71622	7	28378	78476	10	21524	06854	3	93146	39
22	49 4	10 56	71643	8	28357	78505	10	21495	06862	3	93138	38
23	48 56	11 4	71664	8	28336	78533	11	21467	06869	3	93131	37
24	48 48	11 12	71685	8	28315	78562	11	21438	06877	3	93123	36
25	7 48 40	4 11 20	9. 71705	9	10. 28295	9. 78590	12	10. 21410	10. 06885	3	9. 93115	35
26	48 32	11 28	71726	9	28274	78618	12	21382	06892	3	93108	34
27	48 24	11 36	71747	9	28253	78647	13	21353	06900	3	93100	33
28	48 16	11 44	71767	10	28233	78675	13	21325	06908	4	93092	32
29	48 8	11 52	71788	10	28212	78704	14	21296	06916	4	93084	31
30	7 48 0	4 12 0	9. 71809	10	10. 28191	9. 78732	14	10. 21268	10. 06923	4	9. 93077	30
31	47 52	12 8	71829	11	28171	78760	15	21240	06931	4	93069	29
32	47 44	12 16	71850	11	28150	78789	15	21211	06939	4	93061	28
33	47 36	12 24	71870	11	28130	78817	16	21183	06947	4	93053	27
34	47 28	12 32	71891	12	28109	78845	16	21155	06954	4	93046	26
35	7 47 20	4 12 40	9. 71911	12	10. 28089	9. 78874	17	10. 21126	10. 06962	5	9. 93038	25
36	47 12	12 48	71932	12	28068	78902	17	21098	06970	5	93030	24
37	47 4	12 56	71952	13	28048	78930	17	21070	06978	5	93022	23
38	46 56	13 4	71973	13	28027	78959	18	21041	06986	5	93014	22
39	46 48	13 12	71994	13	28006	78987	18	21013	06993	5	93007	21
40	7 46 40	4 13 20	9. 72014	14	10. 27986	9. 79015	19	10. 20985	10. 07001	5	9. 92999	20
41	46 32	13 28	72034	14	27966	79043	19	20957	07009	5	92991	19
42	46 24	13 36	72055	14	27945	79072	20	20928	07017	5	92983	18
43	46 16	13 44	72075	15	27925	79100	20	20900	07024	6	92976	17
44	46 8	13 52	72096	15	27904	79128	21	20872	07032	6	92968	16
45	7 46 0	4 14 0	9. 72116	15	10. 27884	9. 79156	21	10. 20844	10. 07040	6	9. 92960	15
46	45 52	14 8	72137	16	27863	79185	22	20815	07048	6	92952	14
47	45 44	14 16	72157	16	27843	79213	22	20787	07056	6	92944	13
48	45 36	14 24	72177	16	27823	79241	23	20759	07064	6	92936	12
49	45 28	14 32	72198	17	27802	79269	23	20731	07071	6	92929	11
50	7 45 20	4 14 40	9. 72218	17	10. 27782	9. 79297	24	10. 20703	10. 07079	6	9. 92921	10
51	45 12	14 48	72238	18	27762	79326	24	20674	07087	7	92913	9
52	45 4	14 56	72259	18	27741	79354	25	20646	07095	7	92905	8
53	44 56	15 4	72279	18	27721	79382	25	20618	07103	7	92897	7
54	44 48	15 12	72299	19	27701	79410	26	20590	07111	7	92889	6
55	7 44 40	4 15 20	9. 72320	19	10. 27680	9. 79438	26	10. 20562	10. 07119	7	9. 92881	5
56	44 32	15 28	72340	19	27660	79466	26	20534	07126	7	92874	4
57	44 24	15 36	72360	20	27640	79495	27	20505	07134	7	92866	3
58	44 16	15 44	72381	20	27619	79523	27	20477	07142	7	92858	2
59	44 8	15 52	72401	20	27599	79551	28	20449	07150	8	92850	1
60	44 0	16 0	72421	21	27579	79579	28	20421	07158	8	92842	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff.	Secant.	Cotangent.	Diff.	Tangent.	Cosecant.	Diff.	Sine.	M.
121°			A		A	B		B	C		C	58°

Seconds of time		1ˢ	2ˢ	3ˢ	4ˢ	5ˢ	6ˢ	7ˢ
Prop. parts of cols.	A	3	5	8	10	13	15	18
	B	4	7	11	14	18	21	25
	C	1	2	3	4	5	6	7

TABLE 44.

Log. Sines, Tangents, and Secants.

32°			A		A	B		B	C		C	147°
M.	Hour A. M.	Hour P. M.	Sine.	Diff.	Cosecant.	Tangent.	Diff.	Cotangent.	Secant.	Diff.	Cosine.	M.
0	7 44 0	4 16 0	9. 72421	0	10. 27579	9. 79579	0	10. 20421	10. 07158	0	9. 92842	60
1	43 52	16 8	72441	0	27559	79607	0	20393	07166	0	92834	59
2	43 44	16 16	72461	1	27539	79635	1	20365	07174	0	92826	58
3	43 36	16 24	72482	1	27518	79663	1	20337	07182	0	92818	57
4	43 28	16 32	72502	1	27498	79691	2	20309	07190	1	92810	56
5	7 43 20	4 16 40	9. 72522	2	10. 27478	9. 79719	2	10. 20281	10. 07197	1	9. 92803	55
6	43 12	16 48	72542	2	27458	79747	3	20253	07205	1	92795	54
7	43 4	16 56	72562	2	27438	79776	3	20224	07213	1	92787	53
8	42 56	17 4	72582	3	27418	79804	4	20196	07221	1	92779	52
9	42 48	17 12	72602	3	27398	79832	4	20168	07229	1	92771	51
10	7 42 40	4 17 20	9. 72622	3	10. 27378	9. 79860	5	10. 20140	10. 07237	1	9. 92763	50
11	42 32	17 28	72643	4	27357	79888	5	20112	07245	1	92755	49
12	42 24	17 36	72663	4	27337	79916	6	20084	07253	2	92747	48
13	42 16	17 44	72683	4	27317	79944	6	20056	07261	2	92739	47
14	42 8	17 52	72703	5	27297	79972	7	20028	07269	2	92731	46
15	7 42 0	4 18 0	9. 72723	5	10. 27277	9. 80000	7	10. 20000	10. 07277	2	9. 92723	45
16	41 52	18 8	72743	5	27257	80028	7	19972	07285	2	92715	44
17	41 44	18 16	72763	6	27237	80056	8	19944	07293	2	92707	43
18	41 36	18 24	72783	6	27217	80084	8	19916	07301	2	92699	42
19	41 28	18 32	72803	6	27197	80112	9	19888	07309	3	92691	41
20	7 41 20	4 18 40	9. 72823	7	10. 27177	9. 80140	9	10. 19860	10. 07317	3	9. 92683	40
21	41 12	18 48	72843	7	27157	80168	10	19832	07325	3	92675	39
22	41 4	18 56	72863	7	27137	80195	10	19805	07333	3	92667	38
23	40 56	19 4	72883	8	27117	80223	11	19777	07341	3	92659	37
24	40 48	19 12	72902	8	27098	80251	11	19749	07349	3	92651	36
25	7 40 40	4 19 20	9. 72922	8	10. 27078	9. 80279	12	10. 19721	10. 07357	3	9. 92643	35
26	40 32	19 28	72942	9	27058	80307	12	19693	07365	3	92635	34
27	40 24	19 36	72962	9	27038	80335	13	19665	07373	4	92627	33
28	40 16	19 44	72982	9	27018	80363	13	19637	07381	4	92619	32
29	40 8	19 52	73002	10	26998	80391	13	19609	07389	4	92611	31
30	7 40 0	4 20 0	9. 73022	10	10. 26978	9. 80419	14	10. 19581	10. 07397	4	9. 92603	30
31	39 52	20 8	73041	10	26959	80447	14	19553	07405	4	92595	29
32	39 44	20 16	73061	11	26939	80474	15	19526	07413	4	92587	28
33	39 36	20 24	73081	11	26919	80502	15	19498	07421	4	92579	27
34	39 28	20 32	73101	11	26899	80530	16	19470	07429	5	92571	26
35	7 39 20	4 20 40	9. 73121	12	10. 26879	9. 80558	16	10. 19442	10. 07437	5	9. 92563	25
36	39 12	20 48	73140	12	26860	80586	17	19414	07445	5	92555	24
37	39 4	20 56	73160	12	26840	80614	17	19386	07454	5	92546	23
38	38 56	21 4	73180	13	26820	80642	18	19358	07462	5	92538	22
39	38 48	21 12	73200	13	26800	80669	18	19331	07470	5	92530	21
40	7 38 40	4 21 20	9. 73219	13	10. 26781	9. 80697	19	10. 19303	10. 07478	5	9. 92522	20
41	38 32	21 28	73239	14	26761	80725	19	19275	07486	6	92514	19
42	38 24	21 36	73259	14	26741	80753	20	19247	07494	6	92506	18
43	38 16	21 44	73278	14	26722	80781	20	19219	07502	6	92498	17
44	38 8	21 52	73298	15	26702	80808	20	19192	07510	6	92490	16
45	7 38 0	4 22 0	9. 73318	15	10. 26682	9. 80836	21	10. 19164	10. 07518	6	9. 92482	15
46	37 52	22 8	73337	15	26663	80864	21	19136	07527	6	92473	14
47	37 44	22 16	73357	16	26643	80892	22	19108	07535	6	92465	13
48	37 36	22 24	73377	16	26623	80919	22	19081	07543	6	92457	12
49	37 28	22 32	73396	16	26604	80947	23	19053	07551	7	92449	11
50	7 37 20	4 22 40	9. 73416	17	10. 26584	9. 80975	23	10. 19025	10. 07559	7	9. 92441	10
51	37 12	22 48	73435	17	26565	81003	24	18997	07567	7	92433	9
52	37 4	22 56	73455	17	26545	81030	24	18970	07575	7	92425	8
53	36 56	23 4	73474	18	26526	81058	25	18942	07584	7	92416	7
54	36 48	23 12	73494	18	26506	81086	25	18914	07592	7	92408	6
55	7 36 40	4 23 20	9. 73513	18	10. 26487	9. 81113	26	10. 18887	10. 07600	7	9. 92400	5
56	36 32	23 28	73533	19	26467	81141	26	18859	07608	8	92392	4
57	36 24	23 36	73552	19	26448	81169	26	18831	07616	8	92384	3
58	36 16	23 44	73572	19	26428	81196	27	18804	07624	8	92376	2
59	36 8	23 52	73591	20	26409	81224	27	18776	07633	8	92367	1
60	36 0	24 0	73611	20	26389	81252	28	18748	07641	8	92359	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff.	Secant.	Cotangent.	Diff.	Tangent.	Cosecant.	Diff.	Sine.	M.
122°			A		A	B		B	C		C	57°

Seconds of time		1ˢ	2ˢ	3ˢ	4ˢ	5ˢ	6ˢ	7ˢ
Prop. parts of cols.	A	2	5	7	10	12	15	17
	B	3	7	10	14	17	21	24
	C	1	2	3	4	5	6	7

TABLE 44.

Log. Sines, Tangents, and Secants.

33°			A		A	B		B	C		C	146°
M.	Hour A. M.	Hour P. M.	Sine.	Diff.	Cosecant.	Tangent.	Diff.	Cotangent.	Secant.	Diff.	Cosine.	M.
0	7 36 0	4 24 0	9. 73611	0	10. 26389	9. 81252	0	10. 18748	10. 07641	0	9. 92359	60
1	35 52	24 8	73630	0	26370	81279	0	18721	07649	0	92351	59
2	35 44	24 16	73650	1	26350	81307	1	18693	07657	0	92343	58
3	35 36	24 24	73669	1	26331	81335	1	18665	07665	0	92335	57
4	35 28	24 32	73689	1	26311	81362	2	18638	07674	1	92326	56
5	7 35 20	4 24 40	9. 73708	2	10. 26292	9. 81390	2	10. 18610	10. 07682	1	9. 92318	55
6	35 12	24 48	73727	2	26273	81418	3	18582	07690	1	92310	54
7	35 4	24 56	73747	2	26253	81445	3	18555	07698	1	92302	53
8	34 56	25 4	73766	3	26234	81473	4	18527	07707	1	92293	52
9	34 48	25 12	73785	3	26215	81500	4	18500	07715	1	92285	51
10	7 34 40	4 25 20	9. 73805	3	10. 26195	9. 81528	5	10. 18472	10. 07723	1	9. 92277	50
11	34 32	25 28	73824	3	26176	81556	5	18444	07731	2	92269	49
12	34 24	25 36	73843	4	26157	81583	5	18417	07740	2	92260	48
13	34 16	25 44	73863	4	26137	81611	6	18389	07748	2	92252	47
14	34 8	25 52	73882	4	26118	81638	6	18362	07756	2	92244	46
15	7 34 0	4 26 0	9. 73901	5	10. 26099	9. 81666	7	10. 18334	10. 07765	2	9. 92235	45
16	33 52	26 8	73921	5	26079	81693	7	18307	07773	2	92227	44
17	33 44	26 16	73940	5	26060	81721	8	18279	07781	2	92219	43
18	33 36	26 24	73959	6	26041	81748	8	18252	07789	3	92211	42
19	33 28	26 32	73978	6	26022	81776	9	18224	07798	3	92202	41
20	7 33 20	4 26 40	9. 73997	6	10. 26003	9. 81803	9	10. 18197	10. 07806	3	9. 92194	40
21	33 12	26 48	74017	7	25983	81831	10	18169	07814	3	92186	39
22	33 4	26 56	74036	7	25964	81858	10	18142	07823	3	92177	38
23	32 56	27 4	74055	7	25945	81886	11	18114	07831	3	92169	37
24	32 48	27 12	74074	8	25926	81913	11	18087	07839	3	92161	36
25	7 32 40	4 27 20	9. 74093	8	10. 25907	9. 81941	11	10. 18059	10. 07848	3	9. 92152	35
26	32 32	27 28	74113	8	25887	81968	12	18032	07856	4	92144	34
27	32 24	27 36	74132	9	25868	81996	12	18004	07864	4	92136	33
28	32 16	27 44	74151	9	25849	82023	13	17977	07873	4	92127	32
29	32 8	27 52	74170	9	25830	82051	13	17949	07881	4	92119	31
30	7 32 0	4 28 0	9. 74189	10	10. 25811	9. 82078	14	10. 17922	10. 07889	4	9. 92111	30
31	31 52	28 8	74208	10	25792	82106	14	17894	07898	4	92102	29
32	31 44	28 16	74227	10	25773	82133	15	17867	07906	4	92094	28
33	31 36	28 24	74246	10	25754	82161	15	17839	07914	5	92086	27
34	31 28	28 32	74265	11	25735	82188	16	17812	07923	5	92077	26
35	7 31 20	4 28 40	9. 74284	11	10. 25716	9. 82215	16	10. 17785	10. 07931	5	9. 92069	25
36	31 12	28 48	74303	11	25697	82243	16	17757	07940	5	92060	24
37	31 4	28 56	74322	12	25678	82270	17	17730	07948	5	92052	23
38	30 56	29 4	74341	12	25659	82298	17	17702	07956	5	92044	22
39	30 48	29 12	74360	12	25640	82325	18	17675	07965	5	92035	21
40	7 30 40	4 29 20	9. 74379	13	10. 25621	9. 82352	18	10. 17648	10. 07973	6	9. 92027	20
41	30 32	29 28	74398	13	25602	82380	19	17620	07982	6	92018	19
42	30 24	29 36	74417	13	25583	82407	19	17593	07990	6	92010	18
43	30 16	29 44	74436	14	25564	82435	20	17565	07998	6	92002	17
44	30 8	29 52	74455	14	25545	82462	20	17538	08007	6	91993	16
45	7 30 0	4 30 0	9. 74474	14	10. 25526	9. 82489	21	10. 17511	10. 08015	6	9. 91985	15
46	29 52	30 8	74493	15	25507	82517	21	17483	08024	6	91976	14
47	29 44	30 16	74512	15	25488	82544	22	17456	08032	7	91968	13
48	29 36	30 24	74531	15	25469	82571	22	17429	08041	7	91959	12
49	29 28	30 32	74549	16	25451	82599	22	17401	08049	7	91951	11
50	7 29 20	4 30 40	9. 74568	16	10. 25432	9. 82626	23	10. 17374	10. 08058	7	9. 91942	10
51	29 12	30 48	74587	16	25413	82653	23	17347	08066	7	91934	9
52	29 4	30 56	74606	17	25394	82681	24	17319	08075	7	91925	8
53	28 56	31 4	74625	17	25375	82708	24	17292	08083	7	91917	7
54	28 48	31 12	74644	17	25356	82735	25	17265	08092	8	91908	6
55	7 28 40	4 31 20	9. 74662	17	10. 25338	9. 82762	25	10. 17238	10. 08100	8	9. 91900	5
56	28 32	31 28	74681	18	25319	82790	26	17210	08109	8	91891	4
57	28 24	31 36	74700	18	25300	82817	26	17183	08117	8	91883	3
58	28 16	31 44	74719	18	25281	82844	27	17156	08126	8	91874	2
59	28 8	31 52	74737	19	25263	82871	27	17129	08134	8	91866	1
60	28 0	32 0	74756	19	25244	82899	27	17101	08143	8	91857	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff.	Secant.	Cotangent.	Diff.	Tangent.	Cosecant.	Diff.	Sine.	M.
123°			A		A	B		B	C		C	56°

Seconds of time.......		1s	2s	3s	4s	5s	6s	7s
Prop. parts of cols.	A	2	5	7	10	12	14	17
	B	3	7	10	14	17	21	24
	C	1	2	3	4	5	6	7

TABLE 44.

Log. Sines, Tangents, and Secants.

34°			A		A	B		B	C		C	145°
M.	Hour A. M.	Hour P. M.	Sine.	Diff.	Cosecant	Tangent.	Diff.	Cotangent.	Secant.	Diff.	Cosine.	M.
0	7 28 0	4 32 0	9.74756	0	10.25244	9.82899	0	10.17101	10.08143	0	9.91857	60
1	27 52	32 8	74775	0	25225	82926	0	17074	08151	0	91849	59
2	27 44	32 16	74794	1	25206	82953	1	17047	08160	0	91840	58
3	27 36	32 24	74812	1	25188	82980	1	17020	08168	0	91832	57
4	27 28	32 32	74831	1	25169	83008	2	16992	08177	1	91823	56
5	7 27 20	4 32 40	9.74850	2	10.25150	9.83035	2	10.16965	10.08185	1	9.91815	55
6	27 12	32 48	74868	2	25132	83062	3	16938	08194	1	91806	54
7	27 4	32 56	74887	2	25113	83089	3	16911	08202	1	91798	53
8	26 56	33 4	74906	2	25094	83117	4	16883	08211	1	91789	52
9	26 48	33 12	74924	3	25076	83144	4	16856	08219	1	91781	51
10	7 26 40	4 33 20	9.74943	3	10.25057	9.83171	5	10.16829	10.08228	1	9.91772	50
11	26 32	33 28	74961	3	25039	83198	5	16802	08237	2	91763	49
12	26 24	33 36	74980	4	25020	83225	5	16775	08245	2	91755	48
13	26 16	33 44	74999	4	25001	83252	6	16748	08254	2	91746	47
14	26 8	33 52	75017	4	24983	83280	6	16720	08262	2	91738	46
15	7 26 0	4 34 0	9.75036	5	10.24964	9.83307	7	10.16693	10.08271	2	9.91729	45
16	25 52	34 8	75054	5	24946	83334	7	16666	08280	2	91720	44
17	25 44	34 16	75073	5	24927	83361	8	16639	08288	2	91712	43
18	25 36	34 24	75091	6	24909	83388	8	16612	08297	3	91703	42
19	25 28	34 32	75110	6	24890	83415	9	16585	08305	3	91695	41
20	7 25 20	4 34 40	9.75128	6	10.24872	9.83442	9	10.16558	10.08314	3	9.91686	40
21	25 12	34 48	75147	6	24853	83470	9	16530	08323	3	91677	39
22	25 4	34 56	75165	7	24835	83497	10	16503	08331	3	91669	38
23	24 56	35 4	75184	7	24816	83524	10	16476	08340	3	91660	37
24	24 48	35 12	75202	7	24798	83551	11	16449	08349	3	91651	36
25	7 24 40	4 35 20	9.75221	8	10.24779	9.83578	11	10.16422	10.08357	4	9.91643	35
26	24 32	35 28	75239	8	24761	83605	12	16395	08366	4	91634	34
27	24 24	35 36	75258	8	24742	83632	12	16368	08375	4	91625	33
28	24 16	35 44	75276	9	24724	83659	13	16341	08383	4	91617	32
29	24 8	35 52	75294	9	24706	83686	13	16314	08392	4	91608	31
30	7 24 0	4 36 0	9.75313	9	10.24687	9.83713	14	10.16287	10.08401	4	9.91599	30
31	23 52	36 8	75331	9	24669	83740	14	16260	08409	4	91591	29
32	23 44	36 16	75350	10	24650	83768	14	16232	08418	5	91582	28
33	23 36	36 24	75368	10	24632	83795	15	16205	08427	5	91573	27
34	23 28	36 32	75386	10	24614	83822	15	16178	08435	5	91565	26
35	7 23 20	4 36 40	9.75405	11	10.24595	9.83849	16	10.16151	10.08444	5	9.91556	25
36	23 12	36 48	75423	11	24577	83876	16	16124	08453	5	91547	24
37	23 4	36 56	75441	11	24559	83903	17	16097	08462	5	91538	23
38	22 56	37 4	75459	12	24541	83930	17	16070	08470	5	91530	22
39	22 48	37 12	75478	12	24522	83957	18	16043	08479	6	91521	21
40	7 22 40	4 37 20	9.75496	12	10.24504	9.83984	18	10.16016	10.08488	6	9.91512	20
41	22 32	37 28	75514	13	24486	84011	18	15989	08496	6	91504	19
42	22 24	37 36	75533	13	24467	84038	19	15962	08505	6	91495	18
43	22 16	37 44	75551	13	24449	84065	19	15935	08514	6	91486	17
44	22 8	37 52	75569	13	24431	84092	20	15908	08523	6	91477	16
45	7 22 0	4 38 0	9.75587	14	10.24413	9.84119	20	10.15881	10.08531	7	9.91469	15
46	21 52	38 8	75605	14	24395	84146	21	15854	08540	7	91460	14
47	21 44	38 16	75624	14	24376	84173	21	15827	08549	7	91451	13
48	21 36	38 24	75642	15	24358	84200	22	15800	08558	7	91442	12
49	21 28	38 32	75660	15	24340	84227	22	15773	08567	7	91433	11
50	7 21 20	4 38 40	9.75678	15	10.24322	9.84254	23	10.15746	10.08575	7	9.91425	10
51	21 12	38 48	75696	16	24304	84280	23	15720	08584	7	91416	9
52	21 4	38 56	75714	16	24286	84307	23	15693	08593	8	91407	8
53	20 56	39 4	75733	16	24267	84334	24	15666	08602	8	91398	7
54	20 48	39 12	75751	17	24249	84361	24	15639	08611	8	91389	6
55	7 20 40	4 39 20	9.75769	17	10.24231	9.84388	25	10.15612	10.08619	8	9.91381	5
56	20 32	39 28	75787	17	24213	84415	25	15585	08628	8	91372	4
57	20 24	39 36	75805	17	24195	84442	26	15558	08637	8	91363	3
58	20 16	39 44	75823	18	24177	84469	26	15531	08646	8	91354	2
59	20 8	39 52	75841	18	24159	84496	27	15504	08655	9	91345	1
60	20 0	40 0	75859	18	24141	84523	27	15477	08664	9	91336	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff.	Secant.	Cotangent.	Diff.	Tangent.	Cosecant.	Diff.	Sine.	M.
124°			A		A	B		B	C		C	55°

Seconds of time		1s	2s	3s	4s	5s	6s	7s
Prop. parts of cols.	A	2	5	7	9	11	14	16
	B	3	7	10	14	17	20	24
	C	1	2	3	4	5	7	8

TABLE 44.

Log. Sines, Tangents, and Secants.

35°			A		A	B		B	C		C	144°
M.	Hour A. M.	Hour P. M.	Sine.	Diff.	Cosecant.	Tangent.	Diff.	Cotangent.	Secant.	Diff.	Cosine.	M.
0	7 20 0	4 40 0	9.75859	0	10.24141	9.84523	0	10.15477	10.08664	0	9.91336	60
1	19 52	40 8	75877	0	24123	84550	0	15450	08672	0	91328	59
2	19 44	40 16	75895	1	24105	84576	1	15424	08681	0	91319	58
3	19 36	40 24	75913	1	24087	84603	1	15397	08690	0	91310	57
4	19 28	40 32	75931	1	24069	84630	2	15370	08699	1	91301	56
5	7 19 20	4 40 40	9.75949	1	10.24051	9.84657	2	10.15343	10.08708	1	9.91292	55
6	19 12	40 48	75967	2	24033	84684	3	15316	08717	1	91283	54
7	19 4	40 56	75985	2	24015	84711	3	15289	08726	1	91274	53
8	18 56	41 4	76003	2	23997	84738	4	15262	08734	1	91266	52
9	18 48	41 12	76021	3	23979	84764	4	15236	08743	1	91257	51
10	7 18 40	4 41 20	9.76039	3	10.23961	9.84791	4	10.15209	10.08752	2	9.91248	50
11	18 32	41 28	76057	3	23943	84818	5	15182	08761	2	91239	49
12	18 24	41 36	76075	4	23925	84845	5	15155	08770	2	91230	48
13	18 16	41 44	76093	4	23907	84872	6	15128	08779	2	91221	47
14	18 8	41 52	76111	4	23889	84899	6	15101	08788	2	91212	46
15	7 18 0	4 42 0	9.76129	4	10.23871	9.84925	7	10.15075	10.08797	2	9.91203	45
16	17 52	42 8	76146	5	23854	84952	7	15048	08806	2	91194	44
17	17 44	42 16	76164	5	23836	84979	8	15021	08815	3	91185	43
18	17 36	42 24	76182	5	23818	85006	8	14994	08824	3	91176	42
19	17 28	42 32	76200	6	23800	85033	8	14967	08833	3	91167	41
20	7 17 20	4 42 40	9.76218	6	10.23782	9.85059	9	10.14941	10.08842	3	9.91158	40
21	17 12	42 48	76236	6	23764	85086	9	14914	08851	3	91149	39
22	17 4	42 56	76253	6	23747	85113	10	14887	08859	3	91141	38
23	16 56	43 4	76271	7	23729	85140	10	14860	08868	3	91132	37
24	16 48	43 12	76289	7	23711	85166	11	14834	08877	4	91123	36
25	7 16 40	4 43 20	9.76307	7	10.23693	9.85193	11	10.14807	10.08886	4	9.91114	35
26	16 32	43 28	76324	8	23676	85220	12	14780	08895	4	91105	34
27	16 24	43 36	76342	8	23658	85247	12	14753	08904	4	91096	33
28	16 16	43 44	76360	8	23640	85273	12	14727	08913	4	91087	32
29	16 8	43 52	76378	9	23622	85300	13	14700	08922	4	91078	31
30	7 16 0	4 44 0	9.76395	9	10.23605	9.85327	13	10.14673	10.08931	5	9.91069	30
31	15 52	44 8	76413	9	23587	85354	14	14646	08940	5	91060	29
32	15 44	44 16	76431	9	23569	85380	14	14620	08949	5	91051	28
33	15 36	44 24	76448	10	23552	85407	15	14593	08958	5	91042	27
34	15 28	44 32	76466	10	23534	85434	15	14566	08967	5	91033	26
35	7 15 20	4 44 40	9.76484	10	10.23516	9.85460	16	10.14540	10.08977	5	9.91023	25
36	15 12	44 48	76501	11	23499	85487	16	14513	08986	5	91014	24
37	15 4	44 56	76519	11	23481	85514	16	14486	08995	6	91005	23
38	14 56	45 4	76537	11	23463	85540	17	14460	09004	6	90996	22
39	14 48	45 12	76554	12	23446	85567	17	14433	09013	6	90987	21
40	7 14 40	4 45 20	9.76572	12	10.23428	9.85594	18	10.14406	10.09022	6	9.90978	20
41	14 32	45 28	76590	12	23410	85620	18	14380	09031	6	90969	19
42	14 24	45 36	76607	12	23393	85647	19	14353	09040	6	90960	18
43	14 16	45 44	76625	13	23375	85674	19	14326	09049	6	90951	17
44	14 8	45 52	76642	13	23358	85700	20	14300	09058	7	90942	16
45	7 14 0	4 46 0	9.76660	13	10.23340	9.85727	20	10.14273	10.09067	7	9.90933	15
46	13 52	46 8	76677	14	23323	85754	20	14246	09076	7	90924	14
47	13 44	46 16	76695	14	23305	85780	21	14220	09085	7	90915	13
48	13 36	46 24	76712	14	23288	85807	21	14193	09094	7	90906	12
49	13 28	46 32	76730	14	23270	85834	22	14166	09104	7	90896	11
50	7 13 20	4 46 40	9.76747	15	10.23253	9.85860	22	10.14140	10.09113	8	9.90887	10
51	13 12	46 48	76765	15	23235	85887	23	14113	09122	8	90878	9
52	13 4	46 56	76782	15	23218	85913	23	14087	09131	8	90869	8
53	12 56	47 4	76800	16	23200	85940	24	14060	09140	8	90860	7
54	12 48	47 12	76817	16	23183	85967	24	14033	09149	8	90851	6
55	7 12 40	4 47 20	9.76835	16	10.23165	9.85993	24	10.14007	10.09158	8	9.90842	5
56	12 32	47 28	76852	17	23148	86020	25	13980	09168	8	90832	4
57	12 24	47 36	76870	17	23130	86046	25	13954	09177	9	90823	3
58	12 16	47 44	76887	17	23113	86073	26	13927	09186	9	90814	2
59	12 8	47 52	76904	17	23096	86100	26	13900	09195	9	90805	1
60	12 0	48 0	76922	18	23078	86126	27	13874	09204	9	90796	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff.	Secant.	Cotangent.	Diff.	Tangent.	Cosecant.	Diff.	Sine.	M.
125°			A		A	B		B	C		C	54°

Seconds of time		1s	2s	3s	4s	5s	6s	7s
Prop. parts of cols.	A	2	4	7	9	11	13	16
	B	3	7	10	13	17	20	23
	C	1	2	3	5	6	7	8

TABLE 44.

Log. Sines, Tangents, and Secants.

36°			A		A	B		B	C		C	143°
M.	Hour A. M.	Hour P. M.	Sine.	Diff.	Cosecant.	Tangent.	Diff.	Cotangent.	Secant.	Diff.	Cosine.	M.
0	7 12 0	4 48 0	9.76922	0	10.23078	9.86126	0	10.13874	10.09204	0	9.90796	60
1	11 52	48 8	76939	0	23061	86153	0	13847	09213	0	90787	59
2	11 44	48 16	76957	1	23043	86179	1	13821	09223	0	90777	58
3	11 36	48 24	76974	1	23026	86206	1	13794	09232	0	90768	57
4	11 28	48 32	76991	1	23009	86232	2	13768	09241	1	90759	56
5	7 11 20	4 48 40	9.77009	1	10.22991	9.86259	2	10.13741	10.09250	1	9.90750	55
6	11 12	48 48	77026	2	22974	86285	3	13715	09259	1	90741	54
7	11 4	48 56	77043	2	22957	86312	3	13688	09269	1	90731	53
8	10 56	49 4	77061	2	22939	86338	4	13662	09278	1	90722	52
9	10 48	49 12	77078	3	22922	86365	4	13635	09287	1	90713	51
10	7 10 40	4 49 20	9.77095	3	10.22905	9.86392	4	10.13608	10.09296	2	9.90704	50
11	10 32	49 28	77112	3	22888	86418	5	13582	09306	2	90694	49
12	10 24	49 36	77130	3	22870	86445	5	13555	09315	2	90685	48
13	10 16	49 44	77147	4	22853	86471	6	13529	09324	2	90676	47
14	10 8	49 52	77164	4	22836	86498	6	13502	09333	2	90667	46
15	7 10 0	4 50 0	9.77181	4	10.22819	9.86524	7	10.13476	10.09343	2	9.90657	45
16	9 52	50 8	77199	5	22801	86551	7	13449	09352	2	90648	44
17	9 44	50 16	77216	5	22784	86577	7	13423	09361	3	90639	43
18	9 36	50 24	77233	5	22767	86603	8	13397	09370	3	90630	42
19	9 28	50 32	77250	5	22750	86630	8	13370	09380	3	90620	41
20	7 9 20	4 50 40	9.77268	6	10.22732	9.86656	9	10.13344	10.09389	3	9.90611	40
21	9 12	50 48	77285	6	22715	86683	9	13317	09398	3	90602	39
22	9 4	50 56	77302	6	22698	86709	10	13291	09408	3	90592	38
23	8 56	51 4	77319	7	22681	86736	10	13264	09417	4	90583	37
24	8 48	51 12	77336	7	22664	86762	11	13238	09426	4	90574	36
25	7 8 40	4 51 20	9.77353	7	10.22647	9.86789	11	10.13211	10.09435	4	9.90565	35
26	8 32	51 28	77370	7	22630	86815	11	13185	09445	4	90555	34
27	8 24	51 36	77387	8	22613	86842	12	13158	09454	4	90546	33
28	8 16	51 44	77405	8	22595	86868	12	13132	09463	4	90537	32
29	8 8	51 52	77422	8	22578	86894	13	13106	09473	5	90527	31
30	7 8 0	4 52 0	9.77439	9	10.22561	9.86921	13	10.13079	10.09482	5	9.90518	30
31	7 52	52 8	77456	9	22544	86947	14	13053	09491	5	90509	29
32	7 44	52 16	77473	9	22527	86974	14	13026	09501	5	90499	28
33	7 36	52 24	77490	9	22510	87000	15	13000	09510	5	90490	27
34	7 28	52 32	77507	10	22493	87027	15	12973	09520	5	90480	26
35	7 7 20	4 52 40	9.77524	10	10.22476	9.87053	15	10.12947	10.09529	5	9.90471	25
36	7 12	52 48	77541	10	22459	87079	16	12921	09538	6	90462	24
37	7 4	52 56	77558	11	22442	87106	16	12894	09548	6	90452	23
38	6 56	53 4	77575	11	22425	87132	17	12868	09557	6	90443	22
39	6 48	53 12	77592	11	22408	87158	17	12842	09566	6	90434	21
40	7 6 40	4 53 20	9.77609	11	10.22391	9.87185	18	10.12815	10.09576	6	9.90424	20
41	6 32	53 28	77626	12	22374	87211	18	12789	09585	6	90415	19
42	6 24	53 36	77643	12	22357	87238	18	12762	09595	7	90405	18
43	6 16	53 44	77660	12	22340	87264	19	12736	09604	7	90396	17
44	6 8	53 52	77677	13	22323	87290	19	12710	09614	7	90386	16
45	7 6 0	4 54 0	9.77694	13	10.22306	9.87317	20	10.12683	10.09623	7	9.90377	15
46	5 52	54 8	77711	13	22289	87343	20	12657	09632	7	90368	14
47	5 44	54 16	77728	13	22272	87369	21	12631	09642	7	90358	13
48	5 36	54 24	77744	14	22256	87396	21	12604	09651	7	90349	12
49	5 28	54 32	77761	14	22239	87422	22	12578	09661	8	90339	11
50	7 5 20	4 54 40	9.77778	14	10.22222	9.87448	22	10.12552	10.09670	8	9.90330	10
51	5 12	54 48	77795	15	22205	87475	22	12525	09680	8	90320	9
52	5 4	54 56	77812	15	22188	87501	23	12499	09689	8	90311	8
53	4 56	55 4	77829	15	22171	87527	23	12473	09699	8	90301	7
54	4 48	55 12	77846	15	22154	87554	24	12446	09708	8	90292	6
55	7 4 40	4 55 20	9.77862	16	10.22138	9.87580	24	10.12420	10.09718	9	9.90282	5
56	4 32	55 28	77879	16	22121	87606	25	12394	09727	9	90273	4
57	4 24	55 36	77896	16	22104	87633	25	12367	09737	9	90263	3
58	4 16	55 44	77913	16	22087	87659	26	12341	09746	9	90254	2
59	4 8	55 52	77930	17	22070	87685	26	12315	09756	9	90244	1
60	4 0	56 0	77946	17	22054	87711	26	12289	09765	9	90235	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff.	Secant.	Cotangent.	Diff.	Tangent.	Cosecant.	Diff.	Sine.	M.
126°			A		A	B		B	C		C	53°

Seconds of time		1s	2s	3s	4s	5s	6s	7s
Prop. parts of cols.	A	2	4	6	9	11	13	15
	B	3	7	10	13	17	20	23
	C	1	2	4	5	6	7	8

TABLE 44.

Log. Sines, Tangents, and Secants.

37°			A		A	B		B	C		C	142°
M.	Hour A. M.	Hour P. M.	Sine.	Diff.	Cosecant.	Tangent.	Diff.	Cotangent.	Secant.	Diff.	Cosine.	M.
0	7 4 0	4 56 0	9.77946	0	10.22054	9.87711	0	10.12289	10.09765	0	9.90235	60
1	3 52	56 8	77963	0	22037	87738	0	12262	09775	0	90225	59
2	3 44	56 16	77980	1	22020	87764	1	12236	09784	0	90216	58
3	3 36	56 24	77997	1	22003	87790	1	12210	09794	0	90206	57
4	3 28	56 32	78013	1	21987	87817	2	12183	09803	1	90197	56
5	7 3 20	4 56 40	9.78030	1	10.21970	9.87843	2	10.12157	10.09813	1	9.90187	55
6	3 12	56 48	78047	2	21953	87869	3	12131	09822	1	90178	54
7	3 4	56 56	78063	2	21937	87895	3	12105	09832	1	90168	53
8	2 56	57 4	78080	2	21920	87922	3	12078	09841	1	90159	52
9	2 48	57 12	78097	2	21903	87948	4	12052	09851	1	90149	51
10	7 2 40	4 57 20	9.78113	3	10.21887	9.87974	4	10.12026	10.09861	2	9.90139	50
11	2 32	57 28	78130	3	21870	88000	5	12000	09870	2	90130	49
12	2 24	57 36	78147	3	21853	88027	5	11973	09880	2	90120	48
13	2 16	57 44	78163	4	21837	88053	6	11947	09889	2	90111	47
14	2 8	57 52	78180	4	21820	88079	6	11921	09899	2	90101	46
15	7 2 0	4 58 0	9.78197	4	10.21803	9.88105	7	10.11895	10.09909	2	9.90091	45
16	1 52	58 8	78213	4	21787	88131	7	11869	09918	3	90082	44
17	1 44	58 16	78230	5	21770	88158	7	11842	09928	3	90072	43
18	1 36	58 24	78246	5	21754	88184	8	11816	09937	3	90063	42
19	1 28	58 32	78263	5	21737	88210	8	11790	09947	3	90053	41
20	7 1 20	4 58 40	9.78280	5	10.21720	9.88236	9	10.11764	10.09957	3	9.90043	40
21	1 12	58 48	78296	6	21704	88262	9	11738	09966	3	90034	39
22	1 4	58 56	78313	6	21687	88289	10	11711	09976	4	90024	38
23	0 56	59 4	78329	6	21671	88315	10	11685	09986	4	90014	37
24	0 48	59 12	78346	7	21654	88341	10	11659	09995	4	90005	36
25	7 0 40	4 59 20	9.78362	7	10.21638	9.88367	11	10.11633	10.10005	4	9.89995	35
26	0 32	59 28	78379	7	21621	88393	11	11607	10015	4	89985	34
27	0 24	59 36	78395	7	21605	88420	12	11580	10024	4	89976	33
28	0 16	59 44	78412	8	21588	88446	12	11554	10034	5	89966	32
29	0 8	59 52	78428	8	21572	88472	13	11528	10044	5	89956	31
30	7 0 0	5 0 0	9.78445	8	10.21555	9.88498	13	10.11502	10.10053	5	9.89947	30
31	6 59 52	0 8	78461	9	21539	88524	14	11476	10063	5	89937	29
32	59 44	0 16	78478	9	21522	88550	14	11450	10073	5	89927	28
33	59 36	0 24	78494	9	21506	88577	14	11423	10082	5	89918	27
34	59 28	0 32	78510	9	21490	88603	15	11397	10092	5	89908	26
35	6 59 20	5 0 40	9.78527	10	10.21473	9.88629	15	10.11371	10.10102	6	9.89898	25
36	59 12	0 48	78543	10	21457	88655	16	11345	10112	6	89888	24
37	59 4	0 56	78560	10	21440	88681	16	11319	10121	6	89879	23
38	58 56	1 4	78576	10	21424	88707	17	11293	10131	6	89869	22
39	58 48	1 12	78592	11	21408	88733	17	11267	10141	6	89859	21
40	6 58 40	5 1 20	9.78609	11	10.21391	9.88759	17	10.11241	10.10151	6	9.89849	20
41	58 32	1 28	78625	11	21375	88786	18	11214	10160	7	89840	19
42	58 24	1 36	78642	12	21358	88812	18	11188	10170	7	89830	18
43	58 16	1 44	78658	12	21342	88838	19	11162	10180	7	89820	17
44	58 8	1 52	78674	12	21326	88864	19	11136	10190	7	89810	16
45	6 58 0	5 2 0	9.78691	12	10.21309	9.88890	20	10.11110	10.10199	7	9.89801	15
46	57 52	2 8	78707	13	21293	88916	20	11084	10209	7	89791	14
47	57 44	2 16	78723	13	21277	88942	20	11058	10219	8	89781	13
48	57 36	2 24	78739	13	21261	88968	21	11032	10229	8	89771	12
49	57 28	2 32	78756	13	21244	88994	21	11006	10239	8	89761	11
50	6 57 20	5 2 40	9.78772	14	10.21228	9.89020	22	10.10980	10.10248	8	9.89752	10
51	57 12	2 48	78788	14	21212	89046	22	10954	10258	8	89742	9
52	57 4	2 56	78805	14	21195	89073	23	10927	10268	8	89732	8
53	56 56	3 4	78821	15	21179	89099	23	10901	10278	9	89722	7
54	56 48	3 12	78837	15	21163	89125	24	10875	10288	9	89712	6
55	6 56 40	5 3 20	9.78853	15	10.21147	9.89151	24	10.10849	10.10298	9	9.89702	5
56	56 32	3 28	78869	15	21131	89177	24	10823	10307	9	89693	4
57	56 24	3 36	78886	16	21114	89203	25	10797	10317	9	89683	3
58	56 16	3 44	78902	16	21098	89229	25	10771	10327	9	89673	2
59	56 8	3 52	78918	16	21082	89255	26	10745	10337	10	89663	1
60	56 0	4 0	78934	16	21066	89281	26	10719	10347	10	89653	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff.	Secant.	Cotangent.	Diff.	Tangent.	Cosecant.	Diff.	Sine.	M.
127°			A		A	B		B	C		C	52°

Seconds of time		1s	2s	3s	4s	5s	6s	7s
Prop. parts of cols.	A	2	4	6	8	10	12	14
	B	3	7	10	13	16	20	23
	C	1	2	4	5	6	7	8

TABLE 44.

Log. Sines, Tangents, and Secants.

38°			A		A	B		B	C		C	141°
M.	Hour A. M.	Hour P. M.	Sine.	Diff.	Cosecant.	Tangent.	Diff.	Cotangent.	Secant.	Diff.	Cosine.	M.
0	6 56 0	5 4 0	9.78934	0	10.21066	9.89281	0	10.10719	10.10347	0	9.89653	60
1	55 52	4 8	78950	0	21050	89307	0	10693	10357	0	89643	59
2	55 44	4 16	78967	1	21033	89333	1	10667	10367	0	89633	58
3	55 36	4 24	78983	1	21017	89359	1	10641	10376	1	89624	57
4	55 28	4 32	78999	1	21001	89385	2	10615	10386	1	89614	56
5	6 55 20	5 4 40	9.79015	1	10.20985	9.89411	2	10.10589	10.10396	1	9.89604	55
6	55 12	4 48	79031	2	20969	89437	3	10563	10406	1	89594	54
7	55 4	4 56	79047	2	20953	89463	3	10537	10416	1	89584	53
8	54 56	5 4	79063	2	20937	89489	3	10511	10426	1	89574	52
9	54 48	5 12	79079	2	20921	89515	4	10485	10436	2	89564	51
10	6 54 40	5 5 20	9.79095	3	10.20905	9.89541	4	10.10459	10.10446	2	9.89554	50
11	54 32	5 28	79111	3	20889	89567	5	10433	10456	2	89544	49
12	54 24	5 36	79128	3	20872	89593	5	10407	10466	2	89534	48
13	54 16	5 44	79144	3	20856	89619	6	10381	10476	2	89524	47
14	54 8	5 52	79160	4	20840	89645	6	10355	10486	2	89514	46
15	6 54 0	5 6 0	9.79176	4	10.20824	9.89671	6	10.10329	10.10496	3	9.89504	45
16	53 52	6 8	79192	4	20808	89697	7	10303	10505	3	89495	44
17	53 44	6 16	79208	5	20792	89723	7	10277	10515	3	89485	43
18	53 36	6 24	79224	5	20776	89749	8	10251	10525	3	89475	42
19	53 28	6 32	79240	5	20760	89775	8	10225	10535	3	89465	41
20	6 53 20	5 6 40	9.79256	5	10.20744	9.89801	9	10.10199	10.10545	3	9.89455	40
21	53 12	6 48	79272	6	20728	89827	9	10173	10555	4	89445	39
22	53 4	6 56	79288	6	20712	89853	10	10147	10565	4	89435	38
23	52 56	7 4	79304	6	20696	89879	10	10121	10575	4	89425	37
24	52 48	7 12	79319	6	20681	89905	10	10095	10585	4	89415	36
25	6 52 40	5 7 20	9.79335	7	10.20665	9.89931	11	10.10069	10.10595	4	9.89405	35
26	52 32	7 28	79351	7	20649	89957	11	10043	10605	4	89395	34
27	52 24	7 36	79367	7	20633	89983	12	10017	10615	5	89385	33
28	52 16	7 44	79383	7	20617	90009	12	09991	10625	5	89375	32
29	52 8	7 52	79399	8	20601	90035	13	09965	10636	5	89364	31
30	6 52 0	5 8 0	9.79415	8	10.20585	9.90061	13	10.09939	10.10646	5	9.89354	30
31	51 52	8 8	79431	8	20569	90086	13	09914	10656	5	89344	29
32	51 44	8 16	79447	8	20553	90112	14	09888	10666	5	89334	28
33	51 36	8 24	79463	9	20537	90138	14	09862	10676	6	89324	27
34	51 28	8 32	79478	9	20522	90164	15	09836	10686	6	89314	26
35	6 51 20	5 8 40	9.79494	9	10.20506	9.90190	15	10.09810	10.10696	6	9.89304	25
36	51 12	8 48	79510	10	20490	90216	16	09784	10706	6	89294	24
37	51 4	8 56	79526	10	20474	90242	16	09758	10716	6	89284	23
38	50 56	9 4	79542	10	20458	90268	16	09732	10726	6	89274	22
39	50 48	9 12	79558	10	20442	90294	17	09706	10736	7	89264	21
40	6 50 40	5 9 20	9.79573	11	10.20427	9.90320	17	10.09680	10.10746	7	9.89254	20
41	50 32	9 28	79589	11	20411	90346	18	09654	10756	7	89244	19
42	50 24	9 36	79605	11	20395	90371	18	09629	10767	7	89233	18
43	50 16	9 44	79621	11	20379	90397	19	09603	10777	7	89223	17
44	50 8	9 52	79636	12	20364	90423	19	09577	10787	7	89213	16
45	6 50 0	5 10 0	9.79652	12	10.20348	9.90449	19	10.09551	10.10797	8	9.89203	15
46	49 52	10 8	79668	12	20332	90475	20	09525	10807	8	89193	14
47	49 44	10 16	79684	12	20316	90501	20	09499	10817	8	89183	13
48	49 36	10 24	79699	13	20301	90527	21	09473	10827	8	89173	12
49	49 28	10 32	79715	13	20285	90553	21	09447	10838	8	89162	11
50	6 49 20	5 10 40	9.79731	13	10.20269	9.90578	22	10.09422	10.10848	8	9.89152	10
51	49 12	10 48	79746	14	20254	90604	22	09396	10858	9	89142	9
52	49 4	10 56	79762	14	20238	90630	22	09370	10868	9	89132	8
53	48 56	11 4	79778	14	20222	90656	23	09344	10878	9	89122	7
54	48 48	11 12	79793	14	20207	90682	23	09318	10888	9	89112	6
55	6 48 40	5 11 20	9.79809	15	10.20191	9.90708	24	10.09292	10.10899	9	9.89101	5
56	48 32	11 28	79825	15	20175	90734	24	09266	10909	9	89091	4
57	48 24	11 36	79840	15	20160	90759	25	09241	10919	10	89081	3
58	48 16	11 44	79856	15	20144	90785	25	09215	10929	10	89071	2
59	48 8	11 52	79872	16	20128	90811	26	09189	10940	10	89060	1
60	48 0	12 0	79887	16	20113	90837	26	09163	10950	10	89050	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff.	Secant.	Cotangent.	Diff.	Tangent.	Cosecant.	Diff.	Sine.	M.
128°			A		A	B		B	C		C	51°

Seconds of time		1^s	2^s	3^s	4^s	5^s	6^s	7^s
Prop. parts of cols.	A	2	4	6	8	10	12	14
	B	3	6	10	13	16	19	23
	C	1	3	4	5	6	8	9

TABLE 44.

Log. Sines, Tangents, and Secants.

39°			A		A	B		B	C		C	140°
M.	Hour A. M.	Hour P. M.	Sine.	Diff.	Cosecant.	Tangent.	Diff.	Cotangent.	Secant.	Diff.	Cosine.	M.
0	6 48 0	5 12 0	9.79887	0	10.20113	9.90837	0	10.09163	10.10950	0	9.89050	60
1	47 52	12 8	79903	0	20097	90863	0	09137	10960	0	89040	59
2	47 44	12 16	79918	1	20082	90889	1	09111	10970	0	89030	58
3	47 36	12 24	79934	1	20066	90914	1	09086	10980	1	89020	57
4	47 28	12 32	79950	1	20050	90940	2	09060	10991	1	89009	56
5	6 47 20	5 12 40	9.79965	1	10.20035	9.90966	2	10.09034	10.11001	1	9.88999	55
6	47 12	12 48	79981	2	20019	90992	3	09008	11011	1	88989	54
7	47 4	12 56	79996	2	20004	91018	3	08982	11022	1	88978	53
8	46 56	13 4	80012	2	19988	91043	3	08957	11032	1	88968	52
9	46 48	13 12	80027	2	19973	91069	4	08931	11042	2	88958	51
10	6 46 40	5 13 20	9.80043	3	10.19957	9.91095	4	10.08905	10.11052	2	9.88948	50
11	46 32	13 28	80058	3	19942	91121	5	08879	11063	2	88937	49
12	46 24	13 36	80074	3	19926	91147	5	08853	11073	2	88927	48
13	46 16	13 44	80089	3	19911	91172	6	08828	11083	2	88917	47
14	46 8	13 52	80105	4	19895	91198	6	08802	11094	2	88906	46
15	6 46 0	5 14 0	9.80120	4	10.19880	9.91224	6	10.08776	10.11104	3	9.88896	45
16	45 52	14 8	80136	4	19864	91250	7	08750	11114	3	88886	44
17	45 44	14 16	80151	4	19849	91276	7	08724	11125	3	88875	43
18	45 36	14 24	80166	5	19834	91301	8	08699	11135	3	88865	42
19	45 28	14 32	80182	5	19818	91327	8	08673	11145	3	88855	41
20	6 45 20	5 14 40	9.80197	5	10.19803	9.91353	9	10.08647	10.11156	3	9.88844	40
21	45 12	14 48	80213	5	19787	91379	9	08621	11166	4	88834	39
22	45 4	14 56	80228	6	19772	91404	9	08596	11176	4	88824	38
23	44 56	15 4	80244	6	19756	91430	10	08570	11187	4	88813	37
24	44 48	15 12	80259	6	19741	91456	10	08544	11197	4	88803	36
25	6 44 40	5 15 20	9.80274	6	10.19726	9.91482	11	10.08518	10.11207	4	9.88793	35
26	44 32	15 28	80290	7	19710	91507	11	08493	11218	5	88782	34
27	44 24	15 36	80305	7	19695	91533	12	08467	11228	5	88772	33
28	44 16	15 44	80320	7	19680	91559	12	08441	11239	5	88761	32
29	44 8	15 52	80336	7	19664	91585	12	08415	11249	5	88751	31
30	6 44 0	5 16 0	9.80351	8	10.19649	9.91610	13	10.08390	10.11259	5	9.88741	30
31	43 52	16 8	80366	8	19634	91636	13	08364	11270	5	88730	29
32	43 44	16 16	80382	8	19618	91662	14	08338	11280	6	88720	28
33	43 36	16 24	80397	8	19603	91688	14	08312	11291	6	88709	27
34	43 28	16 32	80412	9	19588	91713	15	08287	11301	6	88699	26
35	6 43 20	5 16 40	9.80428	9	10.19572	9.91739	15	10.08261	10.11312	6	9.88688	25
36	43 12	16 48	80443	9	19557	91765	15	08235	11322	6	88678	24
37	43 4	16 56	80458	9	19542	91791	16	08209	11332	6	88668	23
38	42 56	17 4	80473	10	19527	91816	16	08184	11343	7	88657	22
39	42 48	17 12	80489	10	19511	91842	17	08158	11353	7	88647	21
40	6 42 40	5 17 20	9.80504	10	10.19496	9.91868	17	10.08132	10.11364	7	9.88636	20
41	42 32	17 28	80519	10	19481	91893	18	08107	11374	7	88626	19
42	42 24	17 36	80534	11	19466	91919	18	08081	11385	7	88615	18
43	42 16	17 44	80550	11	19450	91945	18	08055	11395	7	88605	17
44	42 8	17 52	80565	11	19435	91971	19	08029	11406	8	88594	16
45	6 42 0	5 18 0	9.80580	12	10.19420	9.91996	19	10.08004	10.11416	8	9.88584	15
46	41 52	18 8	80595	12	19405	92022	20	07978	11427	8	88573	14
47	41 44	18 16	80610	12	19390	92048	20	07952	11437	8	88563	13
48	41 36	18 24	80625	12	19375	92073	21	07927	11448	8	88552	12
49	41 28	18 32	80641	13	19359	92099	21	07901	11458	9	88542	11
50	6 41 20	5 18 40	9.80656	13	10.19344	9.92125	21	10.07875	10.11469	9	9.88531	10
51	41 12	18 48	80671	13	19329	92150	22	07850	11479	9	88521	9
52	41 4	18 56	80686	13	19314	92176	22	07824	11490	9	88510	8
53	40 56	19 4	80701	14	19299	92202	23	07798	11501	9	88499	7
54	40 48	19 12	80716	14	19284	92227	23	07773	11511	9	88489	6
55	6 40 40	5 19 20	9.80731	14	10.19269	9.92253	24	10.07747	10.11522	10	9.88478	5
56	40 32	19 28	80746	14	19254	92279	24	07721	11532	10	88468	4
57	40 24	19 36	80762	15	19238	92304	24	07696	11543	10	88457	3
58	40 16	19 44	80777	15	19223	92330	25	07670	11553	10	88447	2
59	40 8	19 52	80792	15	19208	92356	25	07644	11564	10	88436	1
60	40 0	20 0	80807	15	19193	92381	26	07619	11575	10	88425	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff.	Secant.	Cotangent.	Diff.	Tangent.	Cosecant.	Diff.	Sine.	M.
129°			A		A	B		B	C		C	50°

Seconds of time.......		1ˢ	2ˢ	3ˢ	4ˢ	5ˢ	6ˢ	7ˢ
Prop. parts of cols.	A	2	4	6	8	10	12	13
	B	3	6	10	13	16	19	23
	C	1	3	4	5	7	8	9

TABLE 44.

Log. Sines, Tangents, and Secants.

40°			A		A	B		B	C		C	139°
M.	Hour A. M.	Hour P. M.	Sine.	Diff.	Cosecant.	Tangent.	Diff.	Cotangent.	Secant.	Diff.	Cosine.	M.
0	6 40 0	5 20 0	9. 80807	0	10. 19193	9. 92381	0	10. 07619	10. 11575	0	9. 88425	60
1	39 52	20 8	80822	0	19178	92407	0	07593	11585	0	88415	59
2	39 44	20 16	80837	0	19163	92433	1	07567	11596	0	88404	58
3	39 36	20 24	80852	1	19148	92458	1	07542	11606	1	88394	57
4	39 28	20 32	80867	1	19133	92484	2	07516	11617	1	88383	56
5	6 39 20	5 20 40	9. 80882	1	10. 19118	9. 92510	2	10. 07490	10. 11628	1	9. 88372	55
6	39 12	20 48	80897	1	19103	92535	3	07465	11638	1	88362	54
7	39 4	20 56	80912	2	19088	92561	3	07439	11649	1	88351	53
8	38 56	21 4	80927	2	19073	92587	3	07413	11660	1	88340	52
9	38 48	21 12	80942	2	19058	92612	4	07388	11670	2	88330	51
10	6 38 40	5 21 20	9. 80957	2	10. 19043	9. 92638	4	10. 07362	10. 11681	2	9. 88319	50
11	38 32	21 28	80972	3	19028	92663	5	07337	11692	2	88308	49
12	38 24	21 36	80987	3	19013	92689	5	07311	11702	2	88298	48
13	38 16	21 44	81002	3	18998	92715	6	07285	11713	2	88287	47
14	38 8	21 52	81017	3	18983	92740	6	07260	11724	3	88276	46
15	6 38 0	5 22 0	9. 81032	4	10. 18968	9. 92766	6	10. 07234	10. 11734	3	9. 88266	45
16	37 52	22 8	81047	4	18953	92792	7	07208	11745	3	88255	44
17	37 44	22 16	81061	4	18939	92817	7	07183	11756	3	88244	43
18	37 36	22 24	81076	4	18924	92843	8	07157	11766	3	88234	42
19	37 28	22 32	81091	5	18909	92868	8	07132	11777	3	88223	41
20	6 37 20	5 22 40	9. 81106	5	10. 18894	9. 92894	9	10. 07106	10. 11788	4	9. 88212	40
21	37 12	22 48	81121	5	18879	92920	9	07080	11799	4	88201	39
22	37 4	22 56	81136	5	18864	92945	9	07055	11809	4	88191	38
23	36 56	23 4	81151	6	18849	92971	10	07029	11820	4	88180	37
24	36 48	23 12	81166	6	18834	92996	10	07004	11831	4	88169	36
25	6 36 40	5 23 20	9. 81180	6	10. 18820	9. 93022	11	10. 06978	10. 11842	4	9. 88158	35
26	36 32	23 28	81195	6	18805	93048	11	06952	11852	5	88148	34
27	36 24	23 36	81210	7	18790	93073	12	06927	11863	5	88137	33
28	36 16	23 44	81225	7	18775	93099	12	06901	11874	5	88126	32
29	36 8	23 52	81240	7	18760	93124	12	06876	11885	5	88115	31
30	6 36 0	5 24 0	9. 81254	7	10. 18746	9. 93150	13	10. 06850	10. 11895	5	9. 88105	30
31	35 52	24 8	81269	8	18731	93175	13	06825	11906	6	88094	29
32	35 44	24 16	81284	8	18716	93201	14	06799	11917	6	88083	28
33	35 36	24 24	81299	8	18701	93227	14	06773	11928	6	88072	27
34	35 28	24 32	81314	8	18686	93252	14	06748	11939	6	88061	26
35	6 35 20	5 24 40	9. 81328	9	10. 18672	9. 93278	15	10. 06722	10. 11949	6	9. 88051	25
36	35 12	24 48	81343	9	18657	93303	15	06697	11960	6	88040	24
37	35 4	24 56	81358	9	18642	93329	16	06671	11971	7	88029	23
38	34 56	25 4	81372	9	18628	93354	16	06646	11982	7	88018	22
39	34 48	25 12	81387	10	18613	93380	17	06620	11993	7	88007	21
40	6 34 40	5 25 20	9. 81402	10	10. 18598	9. 93406	17	10. 06594	10. 12004	7	9. 87996	20
41	34 32	25 28	81417	10	18583	93431	17	06569	12015	7	87985	19
42	34 24	25 36	81431	10	18569	93457	18	06543	12025	8	87975	18
43	34 16	25 44	81446	11	18554	93482	18	06518	12036	8	87964	17
44	34 8	25 52	81461	11	18539	93508	19	06492	12047	8	87953	16
45	6 34 0	5 26 0	9. 81475	11	10. 18525	9. 93533	19	10. 06467	10. 12058	8	9. 87942	15
46	33 52	26 8	81490	11	18510	93559	20	06441	12069	8	87931	14
47	33 44	26 16	81505	12	18495	93584	20	06416	12080	8	87920	13
48	33 36	26 24	81519	12	18481	93610	20	06390	12091	9	87909	12
49	33 28	26 32	81534	12	18466	93636	21	06364	12102	9	87898	11
50	6 33 20	5 26 40	9. 81549	12	10. 18451	9. 93661	21	10. 06339	10. 12113	9	9. 87887	10
51	33 12	26 48	81563	13	18437	93687	22	06313	12123	9	87877	9
52	33 4	26 56	81578	13	18422	93712	22	06288	12134	9	87866	8
53	32 56	27 4	81592	13	18408	93738	23	06262	12145	10	87855	7
54	32 48	27 12	81607	13	18393	93763	23	06237	12156	10	87844	6
55	6 32 40	5 27 20	9. 81622	14	10. 18378	9. 93789	23	10. 06211	10. 12167	10	9. 87833	5
56	32 32	27 28	81636	14	18364	93814	24	06186	12178	10	87822	4
57	32 24	27 36	81651	14	18349	93840	24	06160	12189	10	87811	3
58	32 16	27 44	81665	14	18335	93865	25	06135	12200	10	87800	2
59	32 8	27 52	81680	15	18320	93891	25	06109	12211	11	87789	1
60	32 0	28 0	81694	15	18306	93916	26	06084	12222	11	87778	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff.	Secant.	Cotangent.	Diff.	Tangent.	Cosecant.	Diff.	Sine.	M.
130°			A		A	B		B	C		C	49°

Seconds of time		1ˢ	2ˢ	3ˢ	4ˢ	5ˢ	6ˢ	7ˢ
Prop. parts of cols.	A	2	4	6	7	9	11	13
	B	3	6	10	13	16	19	22
	C	1	3	4	5	7	8	9

TABLE 44.

Log. Sines, Tangents, and Secants.

41°			A		A	B		B	C		C	138°
M.	Hour A. M.	Hour P. M.	Sine.	Diff.	Cosecant.	Tangent.	Diff.	Cotangent.	Secant.	Diff.	Cosine.	M.
0	6 32 0	5 28 0	9.81694	0	10.18306	9.93916	0	10.06084	10.12222	0	9.87778	60
1	31 52	28 8	81709	0	18291	93942	0	06058	12233	0	87767	59
2	31 44	28 16	81723	0	18277	93967	1	06033	12244	0	87756	58
3	31 36	28 24	81738	1	18262	93993	1	06007	12255	1	87745	57
4	31 28	28 32	81752	1	18248	94018	2	05982	12266	1	87734	56
5	6 31 20	5 28 40	9.81767	1	10.18233	9.94044	2	10.05956	10.12277	1	9.87723	55
6	31 12	28 48	81781	1	18219	94069	3	05931	12288	1	87712	54
7	31 4	28 56	81796	2	18204	94095	3	05905	12299	1	87701	53
8	30 56	29 4	81810	2	18190	94120	3	05880	12310	1	87690	52
9	30 48	29 12	81825	2	18175	94146	4	05854	12321	2	87679	51
10	6 30 40	5 29 20	9.81839	2	10.18161	9.94171	4	10.05829	10.12332	2	9.87668	50
11	30 32	29 28	81854	3	18146	94197	5	05803	12343	2	87657	49
12	30 24	29 36	81868	3	18132	94222	5	05778	12354	2	87646	48
13	30 16	29 44	81882	3	18118	94248	6	05752	12365	2	87635	47
14	30 8	29 52	81897	3	18103	94273	6	05727	12376	3	87624	46
15	6 30 0	5 30 0	9.81911	4	10.18089	9.94299	6	10.05701	10.12387	3	9.87613	45
16	29 52	30 8	81926	4	18074	94324	7	05676	12399	3	87601	44
17	29 44	30 16	81940	4	18060	94350	7	05650	12410	3	87590	43
18	29 36	30 24	81955	4	18045	94375	8	05625	12421	3	87579	42
19	29 28	30 32	81969	5	18031	94401	8	05599	12432	4	87568	41
20	6 29 20	5 30 40	9.81983	5	10.18017	9.94426	8	10.05574	10.12443	4	9.87557	40
21	29 12	30 48	81998	5	18002	94452	9	05548	12454	4	87546	39
22	29 4	30 56	82012	5	17988	94477	9	05523	12465	4	87535	38
23	28 56	31 4	82026	5	17974	94503	10	05497	12476	4	87524	37
24	28 48	31 12	82041	6	17959	94528	10	05472	12487	4	87513	36
25	6 28 40	5 31 20	9.82055	6	10.17945	9.94554	11	10.05446	10.12499	5	9.87501	35
26	28 32	31 28	82069	6	17931	94579	11	05421	12510	5	87490	34
27	28 24	31 36	82084	6	17916	94604	11	05396	12521	5	87479	33
28	28 16	31 44	82098	7	17902	94630	12	05370	12532	5	87468	32
29	28 8	31 52	82112	7	17888	94655	12	05345	12543	5	87457	31
30	6 28 0	5 32 0	9.82126	7	10.17874	9.94681	13	10.05319	10.12554	6	9.87446	30
31	27 52	32 8	82141	7	17859	94706	13	05294	12566	6	87434	29
32	27 44	32 16	82155	8	17845	94732	14	05268	12577	6	87423	28
33	27 36	32 24	82169	8	17831	94757	14	05243	12588	6	87412	27
34	27 28	32 32	82184	8	17816	94783	14	05217	12599	6	87401	26
35	6 27 20	5 32 40	9.82198	8	10.17802	9.94808	15	10.05192	10.12610	7	9.87390	25
36	27 12	32 48	82212	9	17788	94834	15	05166	12622	7	87378	24
37	27 4	32 56	82226	9	17774	94859	16	05141	12633	7	87367	23
38	26 56	33 4	82240	9	17760	94884	16	05116	12644	7	87356	22
39	26 48	33 12	82255	9	17745	94910	17	05090	12655	7	87345	21
40	6 26 40	5 33 20	9.82269	10	10.17731	9.94935	17	10.05065	10.12666	7	9.87334	20
41	26 32	33 28	82283	10	17717	94961	17	05039	12678	8	87322	19
42	26 24	33 36	82297	10	17703	94986	18	05014	12689	8	87311	18
43	26 16	33 44	82311	10	17689	95012	18	04988	12700	8	87300	17
44	26 8	33 52	82326	10	17674	95037	19	04963	12712	8	87288	16
45	6 26 0	5 34 0	9.82340	11	10.17660	9.95062	19	10.04938	10.12723	8	9.87277	15
46	25 52	34 8	82354	11	17646	95088	20	04912	12734	9	87266	14
47	25 44	34 16	82368	11	17632	95113	20	04887	12745	9	87255	13
48	25 36	34 24	82382	11	17618	95139	20	04861	12757	9	87243	12
49	25 28	34 32	82396	12	17604	95164	21	04836	12768	9	87232	11
50	6 25 20	5 34 40	9.82410	12	10.17590	9.95190	21	10.04810	10.12779	9	9.87221	10
51	25 12	34 48	82424	12	17576	95215	22	04785	12791	10	87209	9
52	25 4	34 56	82439	12	17561	95240	22	04760	12802	10	87198	8
53	24 56	35 4	82453	13	17547	95266	22	04734	12813	10	87187	7
54	24 48	35 12	82467	13	17533	95291	23	04709	12825	10	87175	6
55	6 24 40	5 35 20	9.82481	13	10.17519	9.95317	23	10.04683	10.12836	10	9.87164	5
56	24 32	35 28	82495	13	17505	95342	24	04658	12847	10	87153	4
57	24 24	35 36	82509	14	17491	95368	24	04632	12859	11	87141	3
58	24 16	35 44	82523	14	17477	95393	25	04607	12870	11	87130	2
59	24 8	35 52	82537	14	17463	95418	25	04582	12881	11	87119	1
60	24 0	36 0	82551	14	17449	95444	25	04556	12893	11	87107	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff.	Secant.	Cotangent.	Diff.	Tangent.	Cosecant.	Diff.	Sine.	M.
131°			A		A	B		B	C		C	48°

Seconds of time		1ˢ	2ˢ	3ˢ	4ˢ	5ˢ	6ˢ	7ˢ
Prop. parts of cols.	A	2	4	5	7	9	11	12
	B	3	6	10	13	16	19	22
	C	2	3	4	6	7	8	10

TABLE 44.

Log. Sines, Tangents, and Secants.

42°			A		A	B		B	C		C	137°
M.	Hour A. M.	Hour P. M.	Sine.	Diff.	Cosecant.	Tangent.	Diff.	Cotangent.	Secant.	Diff.	Cosine.	M.
0	6 24 0	5 36 0	9.82551	0	10.17449	9.95444	0	10.04556	10.12893	0	9.87107	60
1	23 52	36 8	82565	0	17435	95469	0	04531	12904	0	87096	59
2	23 44	36 16	82579	0	17421	95495	1	04505	12915	0	87085	58
3	23 36	36 24	82593	1	17407	95520	1	04480	12927	1	87073	57
4	23 28	36 32	82607	1	17393	95545	2	04455	12938	1	87062	56
5	6 23 20	5 36 40	9.82621	1	10.17379	9.95571	2	10.04429	10.12950	1	9.87050	55
6	23 12	36 48	82635	1	17365	95596	3	04404	12961	1	87039	54
7	23 4	36 56	82649	2	17351	95622	3	04378	12972	1	87028	53
8	22 56	37 4	82663	2	17337	95647	3	04353	12984	2	87016	52
9	22 48	37 12	82677	2	17323	95672	4	04328	12995	2	87005	51
10	6 22 40	5 37 20	9.82691	2	10.17309	9.95698	4	10.04302	10.13007	2	9.86993	50
11	22 32	37 28	82705	3	17295	95723	5	04277	13018	2	86982	49
12	22 24	37 36	82719	3	17281	95748	5	04252	13030	2	86970	48
13	22 16	37 44	82733	3	17267	95774	5	04226	13041	3	86959	47
14	22 8	37 52	82747	3	17253	95799	6	04201	13053	3	86947	46
15	6 22 0	5 38 0	9.82761	3	10.17239	9.95825	6	10.04175	10.13064	3	9.86936	45
16	21 52	38 8	82775	4	17225	95850	7	04150	13076	3	86924	44
17	21 44	38 16	82788	4	17212	95875	7	04125	13087	3	86913	43
18	21 36	38 24	82802	4	17198	95901	8	04099	13098	3	86902	42
19	21 28	38 32	82816	4	17184	95926	8	04074	13110	4	86890	41
20	6 21 20	5 38 40	9.82830	5	10.17170	9.95952	8	10.04048	10.13121	4	9.86879	40
21	21 12	38 48	82844	5	17156	95977	9	04023	13133	4	86867	39
22	21 4	38 56	82858	5	17142	96002	9	03998	13145	4	86855	38
23	20 56	39 4	82872	5	17128	96028	10	03972	13156	4	86844	37
24	20 48	39 12	82885	6	17115	96053	10	03947	13168	5	86832	36
25	6 20 40	5 39 20	9.82899	6	10.17101	9.96078	11	10.03922	10.13179	5	9.86821	35
26	20 32	39 28	82913	6	17087	96104	11	03896	13191	5	86809	34
27	20 24	39 36	82927	6	17073	96129	11	03871	13202	5	86798	33
28	20 16	39 44	82941	6	17059	96155	12	03845	13214	5	86786	32
29	20 8	39 52	82955	7	17045	96180	12	03820	13225	6	86775	31
30	6 20 0	5 40 0	9.82968	7	10.17032	9.96205	13	10.03795	10.13237	6	9.86763	30
31	19 52	40 8	82982	7	17018	96231	13	03769	13248	6	86752	29
32	19 44	40 16	82996	7	17004	96256	14	03744	13260	6	86740	28
33	19 36	40 24	83010	8	16990	96281	14	03719	13272	6	86728	27
34	19 28	40 32	83023	8	16977	96307	14	03693	13283	7	86717	26
35	6 19 20	5 40 40	9.83037	8	10.16963	9.96332	15	10.03668	10.13295	7	9.86705	25
36	19 12	40 48	83051	8	16949	96357	15	03643	13306	7	86694	24
37	19 4	40 56	83065	8	16935	96383	16	03617	13318	7	86682	23
38	18 56	41 4	83078	9	16922	96408	16	03592	13330	7	86670	22
39	18 48	41 12	83092	9	16908	96433	16	03567	13341	8	86659	21
40	6 18 40	5 41 20	9.83106	9	10.16894	9.96459	17	10.03541	10.13353	8	9.86647	20
41	18 32	41 28	83120	9	16880	96484	17	03516	13365	8	86635	19
42	18 24	41 36	83133	10	16867	96510	18	03490	13376	8	86624	18
43	18 16	41 44	83147	10	16853	96535	18	03465	13388	8	86612	17
44	18 8	41 52	83161	10	16839	96560	19	03440	13400	8	86600	16
45	6 18 0	5 42 0	9.83174	10	10.16826	9.96586	19	10.03414	10.13411	9	9.86589	15
46	17 52	42 8	83188	11	16812	96611	19	03389	13423	9	86577	14
47	17 44	42 16	83202	11	16798	96636	20	03364	13435	9	86565	13
48	17 36	42 24	83215	11	16785	96662	20	03338	13446	9	86554	12
49	17 28	42 32	83229	11	16771	96687	21	03313	13458	9	86542	11
50	6 17 20	5 42 40	9.83242	11	10.16758	9.96712	21	10.03288	10.13470	10	9.86530	10
51	17 12	42 48	83256	12	16744	96738	22	03262	13482	10	86518	9
52	17 4	42 56	83270	12	16730	96763	22	03237	13493	10	86507	8
53	16 56	43 4	83283	12	16717	96788	22	03212	13505	10	86495	7
54	16 48	43 12	83297	12	16703	96814	23	03186	13517	10	86483	6
55	6 16 40	5 43 20	9.83310	13	10.16690	9.96839	23	10.03161	10.13528	11	9.86472	5
56	16 32	43 28	83324	13	16676	96864	24	03136	13540	11	86460	4
57	16 24	43 36	83338	13	16662	96890	24	03110	13552	11	86448	3
58	16 16	43 44	83351	13	16649	96915	25	03085	13564	11	86436	2
59	16 8	43 52	83365	14	16635	96940	25	03060	13575	11	86425	1
60	16 0	44 0	83378	14	16622	96966	25	03034	13587	12	86413	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff.	Secant.	Cotangent.	Diff.	Tangent.	Cosecant.	Diff.	Sine.	M.
132°			A		A	B		B	C		C	47°

Seconds of time		1s	2s	3s	4s	5s	6s	7s
Prop. parts of cols.	A	2	3	5	7	9	10	12
	B	3	6	10	13	16	19	22
	C	1	3	4	6	7	9	10

TABLE 44.

Log. Sines, Tangents, and Secants.

44°			A		A	B		B	C		C	135°
M.	Hour A. M.	Hour P. M.	Sine.	Diff.	Cosecant.	Tangent.	Diff.	Cotangent.	Secant.	Diff.	Cosine.	M.
0	6 8 0	5 52 0	9. 84177	0	10. 15823	9. 98484	0	10. 01516	10. 14307	0	9. 85693	60
1	7 52	52 8	84190	0	15810	98509	0	01491	14319	0	85681	59
2	7 44	52 16	84203	0	15797	98534	1	01466	14331	0	85669	58
3	7 36	52 24	84216	1	15784	98560	1	01440	14343	1	85657	57
4	7 28	52 32	84229	1	15771	98585	2	01415	14355	1	85645	56
5	6 7 20	5 52 40	9. 84242	1	10. 15758	9. 98610	2	10. 01390	10. 14368	1	9. 85632	55
6	7 12	52 48	84255	1	15745	98635	3	01365	14380	1	85620	54
7	7 4	52 56	84269	2	15731	98661	3	01339	14392	1	85608	53
8	6 56	53 4	84282	2	15718	98686	3	01314	14404	2	85596	52
9	6 48	53 12	84295	2	15705	98711	4	01289	14417	2	85583	51
10	6 6 40	5 53 20	9. 84308	2	10. 15692	9. 98737	4	10. 01263	10. 14429	2	9. 85571	50
11	6 32	53 28	84321	2	15679	98762	5	01238	14441	2	85559	49
12	6 24	53 36	84334	3	15666	98787	5	01213	14453	2	85547	48
13	6 16	53 44	84347	3	15653	98812	5	01188	14466	3	85534	47
14	6 8	53 52	84360	3	15640	98838	6	01162	14478	3	85522	46
15	6 6 0	5 54 0	9. 84373	3	10. 15627	9. 98863	6	10. 01137	10. 14490	3	9. 85510	45
16	5 52	54 8	84385	3	15615	98888	7	01112	14503	3	85497	44
17	5 44	54 16	84398	4	15602	98913	7	01087	14515	4	85485	43
18	5 36	54 24	84411	4	15589	98939	8	01061	14527	4	85473	42
19	5 28	54 32	84424	4	15576	98964	8	01036	14540	4	85460	41
20	6 5 20	5 54 40	9. 84437	4	10. 15563	9. 98989	8	10. 01011	10. 14552	4	9. 85448	40
21	5 12	54 48	84450	5	15550	99015	9	00985	14564	4	85436	39
22	5 4	54 56	84463	5	15537	99040	9	00960	14577	5	85423	38
23	4 56	55 4	84476	5	15524	99065	10	00935	14589	5	85411	37
24	4 48	55 12	84489	5	15511	99090	10	00910	14601	5	85399	36
25	6 4 40	5 55 20	9. 84502	5	10. 15498	9. 99116	11	10. 00884	10. 14614	5	9. 85386	35
26	4 32	55 28	84515	6	15485	99141	11	00859	14626	5	85374	34
27	4 24	55 36	84528	6	15472	99166	11	00834	14639	6	85361	33
28	4 16	55 44	84540	6	15460	99191	12	00809	14651	6	85349	32
29	4 8	55 52	84553	6	15447	99217	12	00783	14663	6	85337	31
30	6 4 0	5 56 0	9. 84566	6	10. 15434	9. 99242	13	10. 00758	10. 14676	6	9. 85324	30
31	3 52	56 8	84579	7	15421	99267	13	00733	14688	6	85312	29
32	3 44	56 16	84592	7	15408	99293	13	00707	14701	7	85299	28
33	3 36	56 24	84605	7	15395	99318	14	00682	14713	7	85287	27
34	3 28	56 32	84618	7	15382	99343	14	00657	14726	7	85274	26
35	6 3 20	5 56 40	9. 84630	8	10. 15370	9. 99368	15	10. 00632	10. 14738	7	9. 85262	25
36	3 12	56 48	84643	8	15357	99394	15	00606	14750	7	85250	24
37	3 4	56 56	84656	8	15344	99419	16	00581	14763	8	85237	23
38	2 56	57 4	84669	8	15331	99444	16	00556	14775	8	85225	22
39	2 48	57 12	84682	8	15318	99469	16	00531	14788	8	85212	21
40	6 2 40	5 57 20	9. 84694	9	10. 15306	9. 99495	17	10. 00505	10. 14800	8	9. 85200	20
41	2 32	57 28	84707	9	15293	99520	17	00480	14813	8	85187	19
42	2 24	57 36	84720	9	15280	99545	18	00455	14825	9	85175	18
43	2 16	57 44	84733	9	15267	99570	18	00430	14838	9	85162	17
44	2 8	57 52	84745	9	15255	99596	19	00404	14850	9	85150	16
45	6 2 0	5 58 0	9. 84758	10	10. 15242	9. 99621	19	10. 00379	10. 14863	9	9. 85137	15
46	1 52	58 8	84771	10	15229	99646	19	00354	14875	10	85125	14
47	1 44	58 16	84784	10	15216	99672	20	00328	14888	10	85112	13
48	1 36	58 24	84796	10	15204	99697	20	00303	14900	10	85100	12
49	1 28	58 32	84809	11	15191	99722	21	00278	14913	10	85087	11
50	6 1 20	5 58 40	9. 84822	11	10. 15178	9. 99747	21	10. 00253	10. 14926	10	9. 85074	10
51	1 12	58 48	84835	11	15165	99773	21	00227	14938	11	85062	9
52	1 4	58 56	84847	11	15153	99798	22	00202	14951	11	85049	8
53	0 56	59 4	84860	11	15140	99823	22	00177	14963	11	85037	7
54	0 48	59 12	84873	12	15127	99848	23	00152	14976	11	85024	6
55	6 0 40	5 59 20	9. 84885	12	10. 15115	9. 99874	23	10. 00126	10. 14988	11	9. 85012	5
56	0 32	59 28	84898	12	15102	99899	24	00101	15001	12	84999	4
57	0 24	59 36	84911	12	15089	99924	24	00076	15014	12	84986	3
58	0 16	59 44	84923	12	15077	99949	24	00051	15026	12	84974	2
59	0 8	59 52	84936	13	15064	99975	25	00025	15039	12	84961	1
60	0 0	6 0 0	84949	13	15051	10. 00000	25	00000	15051	12	84949	0
M.	Hour P. M.	Hour A. M.	Cosine.	Diff.	Secant.	Cotangent.	Diff.	Tangent.	Cosecant.	Diff.	Sine.	M.
134°			A		A	B		B	C		C	45°

Seconds of time.......		1ˢ	2ˢ	3ˢ	4ˢ	5ˢ	6ˢ	7ˢ
Prop. parts of cols.	A	2	3	5	6	8	10	11
	B	3	6	9	13	16	19	22
	C	2	3	5	6	8	9	11

TABLE 45.

Haversines.

	$0^h\ 10^m$ 2° 30′		$0^h\ 12^m$ 3° 0′		$0^h\ 14^m$ 3° 30′		$0^h\ 16^m$ 4° 0′		$0^h\ 18^m$ 4° 30′		
s ′	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	s
0 0	6.67751	0.00048	6.83584	0.00069	6.96970	0.00093	7.08564	0.00122	7.18790	0.00154	60
2	.68040	.00048	.83825	.00069	.97176	.00094	.08745	.00122	.18950	.00155	58
4+ 1	.68328	.00048	.84065	.00069	.97382	.00094	.08925	.00123	.19111	.00155	56
6	.68615	.00049	.84304	.00070	.97588	.00095	.09105	.00123	.19271	.00156	54
8+ 2	6.68901	0.00049	6.84543	0.00070	6.97793	0.00095	7.09284	0.00124	7.19430	0.00156	52
10	.69186	.00049	.84782	.00070	.97997	.00095	.09464	.00124	.19590	.00157	50
12+ 3	.69470	.00050	.85019	.00071	.98201	.00096	.09642	.00125	.19749	.00158	48
14	.69754	.00050	.85256	.00071	.98405	.00096	.09821	.00125	.19908	.00158	46
16+ 4	6.70036	0.00050	6.85492	0.00072	6.98608	0.00097	7.09999	0.00126	7.20066	0.00159	44
18	.70318	.00050	.85728	.00072	.98811	.00097	.10177	.00126	.20225	.00159	42
20+ 5	.70598	.00051	.85963	.00072	.99013	.00098	.10354	.00127	.20383	.00160	40
22	.70878	.00051	.86197	.00073	.99214	.00098	.10531	.00127	.20540	.00160	38
24+ 6	6.71157	0.00051	6.86431	0.00073	6.99416	0.00099	7.10708	0.00128	7.20698	0.00161	36
26	.71435	.00052	.86664	.00074	6.99616	.00099	.10884	.00128	.20855	.00162	34
28+ 7	.71712	.00052	.86897	.00074	6.99817	.00100	.11060	.00129	.21012	.00162	32
30	.71988	.00052	.87129	.00074	7.00017	.00100	.11236	.00130	.21168	.00163	30
32+ 8	6.72263	0.00053	6.87360	0.00075	7.00216	0.00101	7.11411	0.00130	7.21325	0.00163	28
34	.72537	.00053	.87591	.00075	.00415	.00101	.11586	.00131	.21481	.00164	26
36+ 9	.72811	.00053	.87821	.00076	.00613	.00101	.11760	.00131	.21636	.00165	24
38	.73084	.00054	.88050	.00076	.00811	.00102	.11934	.00132	.21792	.00165	22
40+10	6.73355	0.00054	6.88279	0.00076	7.01009	0.00102	7.12108	0.00132	7.21947	0.00166	20
42	.73626	.00054	.88507	.00077	.01206	.00103	.12282	.00133	.22102	.00166	18
44+11	.73896	.00055	.88735	.00077	.01403	.00103	.12455	.00133	.22256	.00167	16
46	.74166	.00055	.88962	.00078	.01599	.00104	.12627	.00134	.22411	.00168	14
48+12	6.74434	0.00056	6.89188	0.00078	7.01795	0.00104	7.12800	0.00134	7.22565	0.00168	12
50	.74702	.00056	.89414	.00078	.01990	.00105	.12972	.00135	.22718	.00169	10
52+13	.74969	.00056	.89639	.00079	.02185	.00105	.13144	.00135	.22872	.00169	8
54	.75235	.00057	.89864	.00079	.02379	.00106	.13315	.00136	.23025	.00170	6
56+14	6.75500	0.00057	6.90088	0.00080	7.02573	0.00106	7.13486	0.00136	7.23178	0.00171	4
58	6.75764	0.00057	6.90312	0.00080	7.02767	0.00107	7.13657	0.00137	7.23331	0.00171	2
	$23^h\ 49^m$		$23^h\ 47^m$		$23^h\ 45^m$		$23^h\ 43^m$		$23^h\ 41^m$		

	$0^h\ 11^m$ 2° 30′		$0^h\ 13^m$ 3° 0′		$0^h\ 15^m$ 3° 30′		$0^h\ 17^m$ 4° 0′		$0^h\ 19^m$ 4° 30′		
s ′											s
0+15	6.76028	0.00058	6.90535	0.00080	7.02960	0.00107	7.13827	0.00137	7.23483	0.00172	60
2	.76290	.00058	.90757	.00081	.03153	.00108	.13997	.00138	.23635	.00172	58
4+16	.76552	.00058	.90979	.00081	.03345	.00108	.14167	.00139	.23787	.00173	56
6	.76814	.00059	.91200	.00082	.03537	00108	.14337	.00139	.23939	.00174	54
8+17	6.77074	0.00059	6.91421	0.00082	7.03729	0.00109	7.14506	0.00140	7.24090	0.00174	52
10	.77334	.00059	.91641	.00082	.03920	.00109	.14674	.00140	.24241	.00175	50
12+18	.77592	.00060	.91860	.00083	.04110	.00110	.14843	.00141	.24392	.00175	48
14	.77851	.00060	.92079	.00083	.04300	.00110	.15011	.00141	.24543	.00176	46
16+19	6.78108	0.00060	6.92298	0.00084	7.04490	0.00111	7.15179	0.00142	7.24693	0.00177	44
18	.78364	.00061	.92516	.00084	.04680	.00111	.15346	.00142	.24843	.00177	42
20+20	.78620	.00061	.92733	.00085	.04869	.00112	.15513	.00143	.24993	.00178	40
22	.78875	.00061	.92950	.00085	.05057	.00112	.15680	.00143	.25143	.00178	38
24+21	6.79129	0.00062	6.93166	0.00085	7.05245	0.00113	7.15846	0.00144	7.25292	0.00179	36
26	.79383	.00062	.93382	.00086	.05433	.00113	.16013	.00145	.25441	.00180	34
28+22	.79630	.00063	.93597	.00086	.05620	.00114	.16178	.00145	.25590	.00180	32
30	.79888	.00063	.93812	.00087	.05807	.00114	.16344	.00146	.25738	.00181	30
32+23	6.80139	0.00063	6.94026	0.00087	7.05994	0.00115	7.16509	0.00146	7.25886	0.00181	28
34	.80390	.00064	.94239	.00088	.06180	.00115	.16674	.00147	.26034	.00182	26
36+24	.80640	.00064	.94453	.00088	.06366	.00116	.16839	.00147	.26182	.00182	24
38	.80889	.00064	.94665	.00088	.06551	.00116	.17003	.00148	.26330	.00183	22
40+25	6.81137	0.00065	6.94877	0.00089	7.06736	0.00117	7.17167	0.00148	7.26477	0.00184	20
42	.81385	.00065	.95089	.00089	.06920	.00117	.17331	.00149	.26624	.00185	18
44+26	.81632	.00066	.95300	.00090	.07105	.00118	.17494	.00150	.26771	.00185	16
46	.81879	.00066	.95510	.00090	.07288	.00118	.17657	.00150	.26917	.00186	14
48+27	6.82124	0.00066	6.95720	0.00091	7.07472	0.00119	7.17820	0.00151	7.27064	0.00186	12
50	.82369	.00067	.95930	.00091	.07655	.00119	.17982	.00151	.27210	.00187	10
52+28	.82614	.00067	.96139	.00091	.07837	.00120	.18144	.00152	.27355	.00188	8
54	.82857	.00067	.96347	.00092	.08019	.00120	.18306	.00152	.27501	.00188	6
56+29	6.83100	0.00068	6.96555	0.00092	7.08201	0.00121	7.18468	0.00153	7.27646	0.00189	4
58	.83342	.00068	.66763	.00093	.08383	.00121	.18629	.00154	.27791	.00190	2
60+30	6.83584	0.00069	6.96970	0.00093	7.08564	0.00122	7.18790	0.00154	7.27936	0.00190	0
	$23^h\ 48^m$		$23^h\ 46^m$		$23^h\ 44^m$		$23^h\ 42^m$		$23^h\ 40^m$		

TABLE 45.

Haversines.

s ′	$0^h\ 30^m$ 7° 30′		$0^h\ 32^m$ 8° 0′		$0^h\ 34^m$ 8° 30′		$0^h\ 36^m$ 9° 0′		$0^h\ 38^m$ 9° 30′		s
	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	
0 0	7.63120	0.00428	7.68717	0.00487	7.73974	0.00549	7.78929	0.00616	7.83615	0.00686	60
2	.63216	.00429	.68807	.00488	.74059	.00550	.79009	.00617	.83691	.00687	58
4+ 1	.63312	.00430	.68897	.00489	.74143	.00551	.79089	.00618	.83767	.00688	56
6	.63408	.00431	.68987	.00490	.74228	.00552	.79169	.00619	.83842	.00689	54
8+ 2	7.63504	0.00432	7.69077	0.00491	7.74313	0.00554	7.79249	0.00620	7.83918	0.00691	52
10	.63600	.00433	.69167	.00492	.74398	.00555	.79329	.00621	.83994	.00692	50
12+ 3	.63696	.00433	.69257	.00493	.74482	.00556	.79409	.00622	.84070	.00693	48
14	.63792	.00434	.69347	.00494	.74567	.00557	.79489	.00624	.84145	.00694	46
16+ 4	7.63887	0.00435	7.69437	0.00495	7.74651	0.00558	7.79568	0.00625	7.84221	0.00695	44
18	.63983	.00436	.69526	.00496	74735	.00559	.79648	.00626	.84296	.00697	42
20+ 5	.64078	.00437	.69616	.00497	.74819	.00560	.79728	.00627	.84372	.00698	40
22	.64173	.00438	.69705	.00498	.74904	.00561	.79807	.00628	.84447	.00699	38
24+ 6	7.64269	0.00439	7.69794	0.00499	7.74988	0.00562	7.79886	0.00629	7.84522	0.00700	36
26	.64364	.00440	.69883	.00500	.75072	.00563	.79966	.00630	.84597	.00701	34
28+ 7	.64458	.00441	.69972	.00501	.75155	.00564	.80045	.00632	.84672	.00703	32
30	.64553	.00442	.70061	.00502	.75239	.00565	.80124	.00633	.84747	.00704	30
32+ 8	7.64648	0.00443	7.70150	0.00503	7.75323	0.00567	7.80203	0.00634	7.84822	0.00705	28
34	.64743	.00444	.70239	.00504	.75407	.00568	.80282	.00635	.84897	.00706	26
36+ 9	.64837	.00445	.70328	.00505	.75490	.00569	.80361	.00636	.84972	.00707	24
38	.64932	.00446	.70416	.00506	.75574	.00570	.80440	.00637	.85047	.00708	22
40+10	7.65026	0.00447	7.70505	0.00507	7.75657	0.00571	7.80519	0.00639	7.85122	0.00710	20
42	.65120	.00448	.70593	.00508	.75740	.00572	.80598	.00640	.85196	.00711	18
44+11	.65214	.00449	.70682	.00509	.75824	.00573	.80677	.00641	.85271	.00712	16
46	.65308	.00450	.70770	.00510	.75907	.00574	.80755	.00642	.85346	.00714	14
48+12	7.65402	0.00451	7.70858	0.00511	7.75990	0.00575	7.80834	0.00643	7.85420	0.00715	12
50	.65496	.00452	.70946	.00512	.76073	.00576	.80912	.00644	.85494	.00716	10
52+13	.65590	.00453	.71034	.00513	.76156	.00578	.80991	.00646	.85569	.00717	8
54	.65683	.00454	.71122	.00514	.76239	.00579	.81069	.00647	.85643	.00719	6
56+14	7.65777	0.00455	7.71210	0.00515	7.76321	0.00580	7.81147	0.00648	7.85717	0.00720	4
58	7.65870	0.00456	7.71298	0.00516	7.76404	0.00581	7.81225	0.00649	7.85791	0.00721	2
	$23^h\ 29^m$		$23^h\ 27^m$		$23^h\ 25^m$		$23^h\ 23^m$		$23^h\ 21^m$		

s ′	$0^h\ 31^m$ 7° 30′		$0^h\ 33^m$ 8° 0′		$0^h\ 35^m$ 8° 30′		$0^h\ 37^m$ 9° 0′		$0^h\ 39^m$ 9° 30′		s
0+15	7.65964	0.00457	7.71385	0.00517	7.76487	0.00582	7.81303	0.00650	7.85866	0.00722	60
2	.66057	.00458	.71473	.00518	.76569	.00583	.81382	.00651	.85940	.00723	58
4+16	.66150	.00459	.71560	.00520	.76652	.00584	.81459	.00653	.86014	.00725	56
6	.66243	.00460	.71648	.00521	.76734	.00585	.81537	.00654	.86087	.00726	54
8+17	7.66336	0.00461	7.71735	0.00522	7.76816	0.00586	7.81615	0.00655	7.86161	0.00727	52
10	.66429	.00462	.71822	.00523	.76898	.00587	.81693	.00656	.86235	.00729	50
12+18	.66521	.00463	.71909	.00524	.76981	.00589	.81771	.00657	.86309	.00730	48
14	.66614	.00464	.71996	.00525	.77063	.00590	.81848	.00658	.86382	.00731	46
16+19	7.66706	0.00465	7.72083	0.00526	7.77145	0.00591	7.81926	0.00660	7.86456	0.00732	44
18	.66799	.00466	.72170	.00527	.77227	.00592	.82003	.00661	.86530	.00733	42
20+20	.66891	.00467	.72257	.00528	.77308	.00593	.82081	.00662	.86603	.00735	40
22	.66983	.00468	.72343	.00529	.77390	.00594	.82158	.00663	.86676	.00736	38
24+21	7.67075	0.00469	7.72430	0.00530	7.77472	0.00595	7.82235	0.00664	7.86750	0.00737	36
26	.67167	.00470	.72516	.00531	.77553	.00596	.82313	.00665	.86823	.00738	34
28+22	.67259	.00471	.72603	.00532	.77635	.00598	.82390	.00667	.86896	.00740	32
30	.67351	.00472	.72689	.00533	.77716	.00599	.82467	.00668	.86969	.00741	30
32+23	7.67443	0.00473	7.72775	0.00534	7.77798	0.00600	7.82544	0.00669	7.87042	0.00742	28
34	.67535	.00474	.72861	.00535	.77879	.00601	.82621	.00670	.87115	.00743	26
36+24	.67626	.00475	.72948	.00536	.77960	.00602	.82698	.00671	.87188	.00745	24
38	.67718	.00476	.73034	.00537	.78041	.00603	.82774	.00673	.87261	.00746	22
40+25	7.67809	0.00477	7.73119	0.00539	7.78122	0.00604	7.82851	0.00674	7.87334	0.00747	20
42	.67900	.00478	.73205	.00540	.78203	.00605	.82928	.00675	.87407	.00748	18
44+26	.67991	.00479	.73291	.00541	.78284	.00607	.83004	.00676	.87480	.00750	16
46	.68082	.00480	.73377	.00542	.78365	.00608	.83081	.00677	.87552	.00751	14
48+27	7.68173	0.00481	7.73462	0.00543	7.78446	0.00609	7.83157	0.00679	7.87625	0.00752	12
50	.68264	.00482	.73548	.00544	.78526	.00610	.83234	.00680	.87697	.00753	10
52+28	.68355	.00483	.73633	.00545	.78607	.00611	.83310	.00681	.87770	.00755	8
54	.68445	.00484	.73718	.00546	.78688	.00612	.83386	.00682	.87842	.00756	6
56+29	7.68536	0.00485	7.73803	0.00547	7.78768	0.00613	7.83463	0.00683	7.87915	0.00757	4
58	.68627	.00486	.73889	.00548	.78848	.00614	.83539	.00685	.87987	.00758	2
60+30	7.68717	0.00487	7.73974	0.00549	7.78929	0.00616	7.83615	0.00686	7.88059	0.00760	0
	$23^h\ 28^m$		$23^h\ 26^m$		$23^h\ 24^m$		$23^h\ 22^m$		$23^h\ 20^m$		

TABLE 45.

Haversines.

s ′	$0^h\ 50^m$ 12° 30′		$0^h\ 52^m$ 13° 0′		$0^h\ 54^m$ 13° 30′		$0^h\ 56^m$ 14° 0′		$0^h\ 58^m$ 14° 30′		s
	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	
0 0	8.07379	0.01185	8.10772	0.01282	8.14035	0.01382	8.17179	0.01485	8.20211	0.01593	60
2	.07437	.01187	.10827	.01283	.14089	.01383	.17230	.01487	.20261	.01594	58
4+ 1	.07494	.01188	.10883	.01285	.14142	.01385	.17282	.01489	.20310	.01596	56
6	.07552	.01190	.10938	.01286	.14195	.01387	.17333	.01491	.20360	.01598	54
8+ 2	8.07610	0.01192	8.10993	0.01288	8.14248	0.01388	8.17384	0.01492	8.20410	0.01600	52
10	.07667	.01193	.11049	.01290	.14302	.01390	.17436	.01494	.20459	.01602	50
12+ 3	.07725	.01195	.11104	.01291	.14355	.01392	.17487	.01496	.20509	.01604	48
14	.07782	.01196	.11159	.01293	.14408	.01393	.17538	.01498	.20558	.01605	46
16+ 4	8.07839	0.01198	8.11214	0.01295	8.14461	0.01395	8.17590	0.01499	8.20608	0.01607	44
18	.07897	.01199	.11269	.01296	.14514	.01397	.17641	.01501	.20657	.01609	42
20+ 5	.07954	.01201	.11324	.01298	.14567	.01399	.17692	.01503	.20706	.01611	40
22	.08011	.01203	.11379	.01300	.14620	.01400	.17743	.01505	.20756	.01613	38
24+ 6	8.08069	0.01204	8.11435	0.01301	8.14673	0.01402	8.17794	0.01506	8.20805	0.01615	36
26	.08126	.01206	.11490	.01303	.14726	.01404	.17845	.01508	.20854	.01616	34
28+ 7	.08183	.01207	.11544	.01305	.14779	.01405	.17896	.01510	.20904	.01618	32
30	.08240	.01209	.11599	.01306	.14832	.01407	.17947	.01512	.20953	.01620	30
32+ 8	8.08297	0.01211	8.11654	0.01308	8.14885	0.01409	8.17998	0.01513	8.21002	0.01622	28
34	.08354	.01212	.11709	.01309	.14938	.01411	.18049	.01515	.21051	.01624	26
36+ 9	.08411	.01214	.11764	.01311	.14991	.01412	.18100	.01517	.21100	.01626	24
38	.08468	.01215	.11819	.01313	.15043	.01414	.18151	.01519	.21149	.01627	22
40+10	8.08525	0.01217	8.11873	0.01314	8.15096	0.01416	8.18202	0.01521	8.21199	0.01629	20
42	.08582	.01218	.11928	.01316	.15149	.01417	.18253	.01522	.21248	.01631	18
44+11	.08639	.01220	.11983	.01317	.15201	.01419	.18303	.01524	.21297	.01633	16
46	.08696	.01222	.12038	.01319	.15254	.01421	.18354	.01526	.21346	.01635	14
48+12	8.08752	0.01223	8.12092	0.01321	8.15307	0.01423	8.18405	0.01528	8.21395	0.01637	12
50	.08809	.01225	.12147	.01323	.15359	.01424	.18455	.01530	.21444	.01638	10
52+13	.08866	.01226	.12201	.01324	.15412	.01426	.18506	.01531	.21493	.01640	8
54	.08922	.01228	.12256	.01326	.15464	.01428	.18557	.01533	.21541	.01642	6
56+14	8.08979	0.01230	8.12310	0.01328	8.15517	0.01429	8.18607	0.01535	8.21590	0.01644	4
58	8.09036	0.01231	8.12365	0.01329	8.15569	0.01431	8.18658	0.01537	8.21639	0.01646	2
	$23^h\ 9^m$		$23^h\ 7^m$		$23^h\ 5^m$		$23^h\ 3^m$		$23^h\ 1^m$		

s ′	$0^h\ 51^m$ 12° 30′		$0^h\ 53^m$ 13° 0′		$0^h\ 55^m$ 13° 30′		$0^h\ 57^m$ 14° 0′		$0^h\ 59^m$ 14° 30′		s
0+15	8.09092	0.01233	8.12419	0.01331	8.15622	0.01433	8.18709	0.01538	8.21688	0.01648	60
2	.09149	.01234	.12473	.01333	.15674	.01435	.18759	.01540	.21737	.01650	58
4+16	.09205	.01236	.12528	.01334	.15726	.01436	.18810	.01542	.21785	.01651	56
6	.09262	.01238	.12582	.01336	.15779	.01438	.18860	.01544	.21834	.01653	54
8+17	8.09318	0.01239	8.12636	0.01338	8.15831	0.01440	8.18910	0.01546	8.21883	0.01655	52
10	.09374	.01241	.12691	.01339	.15883	.01442	.18961	.01547	.21932	.01657	50
12+18	.09431	.01243	.12745	.01341	.15935	.01443	.19011	.01549	.21980	.01659	48
14	.09487	.01244	.12799	.01343	.15987	.01445	.19062	.01551	.22029	.01661	46
16+19	8.09543	0.01246	8.12853	0.01344	8.16040	0.01447	8.19112	0.01553	8.22077	0.01663	44
18	.09600	.01247	.12907	.01346	.16092	.01448	.19162	.01555	.22126	.01664	42
20+20	.09656	.01249	.12961	.01348	.16144	.01450	.19212	.01556	.22175	.01666	40
22	.09712	.01251	.13015	.01349	.16196	.01452	.19263	.01558	.22223	.01668	38
24+21	8.09768	0.01252	8.13069	0.01351	8.16248	0.01454	8.19313	0.01560	8.22272	0.01670	36
26	.09824	.01254	.13123	.01353	.16300	.01455	.19363	.01562	.22320	.01672	34
28+22	.09880	.01255	.13177	.01354	.16352	.01457	.19413	.01564	.22368	.01674	32
30	.09936	.01257	.13231	.01356	.16404	.01459	.19463	.01565	.22417	.01676	30
32+23	8.09992	0.01259	8.13285	0.01358	8.16456	0.01461	8.19513	0.01567	8.22465	0.01677	28
34	.10048	.01260	.13339	.01360	.16508	.01462	.19563	.01569	.22514	.01679	26
36+24	.10104	.01262	.13392	.01361	.16559	.01464	.19613	.01571	.22562	.01681	24
38	.10160	.01264	.13446	.01363	.16611	.01466	.19663	.01573	.22610	.01683	22
40+25	8.10216	0.01265	8.13500	0.01365	8.16663	0.01468	8.19713	0.01574	8.22658	0.01685	20
42	.10271	.01267	.13554	.01366	.16715	.01469	.19763	.01576	.22707	.01687	18
44+26	.10327	.01268	.13607	.01368	.16766	.01471	.19813	.01578	.22755	.01689	16
46	.10383	.01270	.13661	.01370	.16818	.01473	.19863	.01580	.22803	.01691	14
48+27	8.10439	0.01272	8.13714	0.01371	8.16870	0.01475	8.19913	0.01582	8.22851	0.01693	12
50	.10494	.01273	.13768	.01373	.16921	.01476	.19963	.01584	.22899	.01694	10
52+28	.10550	.01275	.13822	.01375	.16973	.01478	.20012	.01585	.22947	.01696	8
54	.10605	.01277	.13875	.01376	.17024	.01480	.20062	.01587	.22996	.01698	6
56+29	8.10661	0.01278	8.13928	0.01378	8.17076	0.01482	8.20112	0.01589	8.23044	0.01700	4
58	.10716	.01280	.13982	.01380	.17127	.01483	.20162	.01591	.23092	.01702	2
60+30	8.10772	0.01282	8.14035	0.01382	8.17179	0.01485	8.20211	0.01593	8.23140	0.01704	0
	$23^h\ 8^m$		$23^h\ 6^m$		$23^h\ 4^m$		$23^h\ 2^m$		$23^h\ 0^m$		

TABLE 45.

Haversines.

	$1^{h}\,5^{m}$ 16° 15′		$1^{h}\,6^{m}$ 16° 30′		$1^{h}\,7^{m}$ 16° 45′		$1^{h}\,8^{m}$ 17° 0′		$1^{h}\,9^{m}$ 17° 15′		
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	s
0	8.30049	**.01998**	8.31366	**.02059**	8.32663	**.02121**	8.33940	**.02185**	8.35199	**.02249**	*60*
1	.30071	**.01999**	.31388	**.02060**	.32684	**.02122**	.33962	**.02186**	.35220	**.02250**	*59*
2	.30093	**.02000**	.31410	**.02061**	.32706	**.02124**	.33983	**.02187**	.35241	**.02251**	*58*
3	.30115	**.02001**	.31431	**.02062**	.32727	**.02125**	.34004	**.02188**	.35261	**.02252**	*57*
+ 1′	8.30137	**.02002**	8.31453	**.02063**	8.32749	**.02126**	8.34025	**.02189**	8.35282	**.02253**	*56*
5	.30159	**.02003**	.31475	**.02064**	.32770	**.02127**	.34046	**.02190**	.35303	**.02254**	*55*
6	.30182	**.02004**	.31497	**.02065**	.32792	**.02128**	.34067	**.02191**	.35324	**.02255**	*54*
7	.30204	**.02005**	.31518	**.02066**	.32813	**.02129**	.34088	**.02192**	.35345	**.02257**	*53*
+ 2′	8.30226	**.02006**	8.31540	**.02067**	8.32834	**.02130**	8.34109	**.02193**	8.35365	**.02258**	*52*
9	.30248	**.02007**	.31562	**.02068**	.32856	**.02131**	.34130	**.02194**	.35386	**.02259**	*51*
10	.30270	**.02008**	.31584	**.02069**	.32877	**.02132**	.34152	**.02195**	.35407	**.02260**	*50*
11	.30292	**.02009**	.31605	**.02070**	.32899	**.02133**	.34173	**.02196**	.35428	**.02261**	*49*
+ 3′	8.30314	**.02010**	8.31627	**.02071**	8.32920	**.02134**	8.34194	**.02198**	8.35449	**.02262**	*48*
13	.30336	**.02011**	.31649	**.02072**	.32941	**.02135**	.34215	**.02199**	.35469	**.02263**	*47*
14	.30358	**.02012**	.31670	**.02074**	.32963	**.02136**	.34236	**.02200**	.35490	**.02264**	*46*
15	.30380	**.02013**	.31692	**.02075**	.32984	**.02137**	.34257	**.02201**	.35511	**.02265**	*45*
+ 4′	8.30402	**.02014**	8.31714	**.02076**	8.33006	**.02138**	8.34278	**.02202**	8.35532	**.02266**	*44*
17	.30424	**.02015**	.31735	**.02077**	.33027	**.02139**	.34299	**.02203**	.35552	**.02267**	*43*
18	.30446	**.02016**	.31757	**.02078**	.33048	**.02140**	.34320	**.02204**	.35573	**.02268**	*42*
19	.30468	**.02017**	.31779	**.02079**	.33070	**.02141**	.34341	**.02205**	.35594	**.02270**	*41*
+ 5′	8.30490	**.02018**	8.31800	**.02080**	8.33091	**.02142**	8.34362	**.02206**	8.35614	**.02271**	*40*
21	.30512	**.02019**	.31822	**.02081**	.33112	**.02143**	.34383	**.02207**	.35635	**.02272**	*39*
22	.30534	**.02020**	.31844	**.02082**	.33134	**.02145**	.34404	**.02208**	.35656	**.02273**	*38*
23	.30556	**.02021**	.31865	**.02083**	.33155	**.02146**	.34425	**.02209**	.35677	**.02274**	*37*
+ 6′	8.30578	**.02022**	8.31887	**.02084**	8.33176	**.02147**	8.34446	**.02210**	8.35697	**.02275**	*36*
25	.30600	**.02023**	.31909	**.02085**	.33198	**.02148**	.34467	**.02211**	.35718	**.02276**	*35*
26	.30622	**.02024**	.31930	**.02086**	.33219	**.02149**	.34488	**.02212**	.35739	**.02277**	*34*
27	.30644	**.02025**	.31952	**.02087**	.33240	**.02150**	.34509	**.02214**	.35759	**.02278**	*33*
+ 7′	8.30666	**.02026**	8.31974	**.02088**	8.33262	**.02151**	8.34530	**.02215**	8.35780	**.02279**	*32*
29	.30688	**.02027**	.31995	**.02089**	.33283	**.02152**	.34551	**.02216**	.35801	**.02280**	*31*
30	.30710	**.02028**	.32017	**.02090**	.33304	**.02153**	.34572	**.02217**	.35821	**.02281**	*30*
31	.30732	**.02029**	.32039	**.02091**	.33325	**.02154**	.34593	**.02218**	.35842	**.02283**	*29*
+ 8′	8.30754	**.02030**	8.32060	**.02092**	8.33347	**.02155**	8.34614	**.02219**	8.35863	**.02284**	*28*
33	.30776	**.02031**	.32082	**.02093**	.33368	**.02156**	.34635	**.02220**	.35883	**.02285**	*27*
34	.30798	**.02032**	.32103	**.02094**	.33389	**.02157**	.34656	**.02221**	.35904	**.02286**	*26*
35	.30820	**.02033**	.32125	**.02095**	.33411	**.02158**	.34677	**.02222**	.35925	**.02287**	*25*
+ 9′	8.30842	**.02034**	8.32147	**.02096**	8.33432	**.02159**	8.34698	**.02223**	8.35945	**.02288**	*24*
37	.30863	**.02035**	.32168	**.02097**	.33453	**.02160**	.34719	**.02224**	.35966	**.02289**	*23*
38	.30885	**.02036**	.32190	**.02098**	.33474	**.02161**	.34740	**.02225**	.35987	**.02290**	*22*
39	.30907	**.02037**	.32211	**.02099**	.33496	**.02162**	.34761	**.02226**	.36007	**.02291**	*21*
+ 10′	8.30929	**.02038**	8.32233	**.02101**	8.33517	**.02164**	8.34782	**.02227**	8.36028	**.02292**	*20*
41	.30951	**.02039**	.32254	**.02102**	.33538	**.02165**	.34803	**.02229**	.36048	**.02293**	*19*
42	.30973	**.02040**	.32276	**.02103**	.33559	**.02166**	.34823	**.02230**	.36069	**.02295**	*18*
43	.30995	**.02042**	.32297	**.02104**	.33580	**.02167**	.34844	**.02231**	.36090	**.02296**	*17*
+ 11′	8.31017	**.02043**	8.32319	**.02105**	8.33602	**.02168**	8.34865	**.02232**	8.36110	**.02297**	*16*
45	.31039	**.02044**	.32341	**.02106**	.33623	**.02169**	.34886	**.02233**	.36131	**.02298**	*15*
46	.31060	**.02045**	.32362	**.02107**	.33644	**.02170**	.34907	**.02234**	.36151	**.02299**	*14*
47	.31082	**.02046**	.32384	**.02108**	.33665	**.02171**	.34928	**.02235**	.36172	**.02300**	*13*
+ 12′	8.31104	**.02047**	8.82405	**.02109**	8.33686	**.02172**	8.34949	**.02236**	8.36193	**.02301**	*12*
49	.31126	**.02048**	.32427	**.02110**	.33708	**.02173**	.34970	**.02237**	.36213	**.02302**	*11*
50	.31148	**.02049**	.32448	**.02111**	.33729	**.02174**	.34991	**.02238**	.36234	**.02303**	*10*
51	.31170	**.02050**	.32470	**.02112**	.33750	**.02175**	.35011	**.02239**	.36254	**.02304**	*9*
+ 13′	8.31192	**.02051**	8.32491	**.02113**	8.33771	**.02176**	8.35032	**.02240**	8.36275	**.02305**	*8*
53	.31213	**.02052**	.32513	**.02114**	.33792	**.02177**	.35053	**.02241**	.36295	**.02307**	*7*
54	.31235	**.02053**	.32534	**.02115**	.33814	**.02178**	.35074	**.02243**	.36316	**.02308**	*6*
55	.31257	**.02054**	.32556	**.02116**	.33835	**.02179**	.35095	**.02244**	.36337	**.02309**	*5*
+ 14′	8.31279	**.02055**	8.32577	**.02117**	8.33856	**.02181**	8.35116	**.02245**	8.36357	**.02310**	*4*
57	.31301	**.02056**	.32599	**.02118**	.33877	**.02182**	.35137	**.02246**	.36378	**.02311**	*3*
58	.31322	**.02057**	.32620	**.02119**	.33898	**.02183**	.35157	**.02247**	.36398	**.02312**	*2*
59	.31344	**.02058**	.32642	**.02120**	.33919	**.02184**	.35178	**.02248**	.36419	**.02313**	*1*
+ 15′	8.31366	**.02059**	8.32663	**.02121**	8.33940	**.02185**	8.35199	**.02249**	8.36439	**.02314**	*0*
	$22^{h}\,54^{m}$		$22^{h}\,53^{m}$		$22^{h}\,52^{m}$		$22^{h}\,51^{m}$		$22^{h}\,50^{m}$		

TABLE 45.

Haversines.

	$1^h\,15^m$ 18° 45′		$1^h\,16^m$ 19° 0′		$1^h\,17^m$ 19° 15′		$1^h\,18^m$ 19° 30′		$1^h\,19^m$ 19° 45′		
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	s
0	8.42382	.02653	8.43522	.02724	8.44647	.02796	8.45757	.02868	8.46852	.02941	60
1	.42401	.02655	.43541	.02725	.44665	.02797	.45775	.02869	.46871	.02942	59
2	.42420	.02656	.43560	.02726	.44684	.02798	.45794	.02870	.46889	.02944	58
3	.42439	.02657	.43578	.02728	.44703	.02799	.45812	.02871	.46907	.02945	57
+ 1′	8.42458	.02658	8.43597	.02729	8.44721	.02800	8.45830	.02873	8.46925	.02946	56
5	.42477	.02659	.43616	.02730	.44740	.02802	.45849	.02874	.46943	.02947	55
6	.42497	.02661	.43635	.02731	.44758	.02803	.45867	.02875	.46961	.02949	54
7	.42516	.02662	.43654	.02732	.44777	.02804	.45885	.02876	.46979	.02950	53
+ 2′	8.42535	.02663	8.43673	.02734	8.44796	.02805	8.45904	.02878	8.46998	.02951	52
9	.42554	.02664	.43692	.02735	.44814	.02806	.45922	.02879	.47016	.02953	51
10	.42573	.02665	.43710	.02736	.44833	.02808	.45940	.02880	.47034	.02954	50
11	.42592	.02666	.43729	.02737	.44851	.02809	.45959	.02881	.47052	.02955	49
+ 3′	8.42611	.02668	8.43748	.02738	8.44870	.02810	8.45977	.02883	8.47070	.02956	48
13	.42630	.02669	.43767	.02739	.44889	.02811	.45995	.02884	.47088	.02957	47
14	.42649	.02670	.43786	.02741	.44907	.02812	.46014	.02885	.47106	.02958	46
15	.42668	.02671	.43805	.02742	.44926	.02814	.46032	.02886	.47124	.02960	45
+ 4′	8.42687	.02672	8.43823	.02743	8.44944	.02815	8.46050	.02887	8.47142	.02961	44
17	.42706	.02673	.43842	.02744	.44963	.02816	.46069	.02889	.47160	.02962	43
18	.42725	.02675	.43861	.02745	.44981	.02817	.46087	.02890	.47178	.02963	42
19	.42745	.02676	.43880	.02747	.45000	.02818	.46105	.02891	.47197	.02965	41
+ 5′	8.42764	.02677	8.43899	.02748	8.45018	.02820	8.46124	.02892	8.47215	.02966	40
21	.42783	.02678	.43917	.02749	.45037	.02821	.46142	.02893	.47233	.02967	39
22	.42802	.02679	.43936	.02750	.45055	.02822	.46160	.02895	.47251	.02968	38
23	.42821	.02680	.43955	.02751	.45074	.02823	.46179	.02896	.47269	.02970	37
+ 6′	8.42840	.02682	8.43974	.02753	8.45093	.02824	8.46197	.02897	8.47287	.02971	36
25	.42859	.02683	.43992	.02754	.45111	.02826	.46215	.02898	.47305	.02972	35
26	.42878	.02684	.44011	.02755	.45130	.02827	.46233	.02900	.47323	.02973	34
27	.42897	.02685	.44030	.02756	.45148	.02828	.46252	.02901	.47341	.02974	33
+ 7′	8.42916	.02686	8.44049	.02757	8.45167	.02829	8.46270	.02902	8.47359	.02976	32
29	.42935	.02688	.44067	.02759	.45185	.02830	.46288	.02903	.47377	.02977	31
30	.42954	.02689	.44086	.02760	.45204	.02832	.46306	.02904	.47395	.02978	30
31	.42973	.02690	.44105	.02761	.45222	.02833	.46325	.02906	.47413	.02979	29
+ 8′	8.42992	.02691	8.44124	.02762	8.45241	.02834	8.46343	.02907	8.47431	.02981	28
33	.43011	.02692	.44142	.02763	.45259	.02835	.46361	.02908	.47449	.02982	27
34	.43030	.02693	.44161	.02764	.45278	.02836	.46379	.02909	.47467	.02983	26
35	.43049	.02695	.44180	.02766	.45296	.02838	.46398	.02911	.47485	.02984	25
+ 9′	8.43068	.02696	8.44199	.02767	8.45315	.02839	8.46416	.02912	8.47503	.02986	24
37	.43087	.02697	.44217	.02768	.45333	.02840	.46434	.02913	.47521	.02987	23
38	.43106	.02698	.44236	.02769	.45352	.02841	.46452	.02914	.47539	.02988	22
39	.43125	.02699	.44255	.02771	.45370	.02842	.46471	.02915	.47557	.02989	21
+ 10′	8.43144	.02700	8.44273	.02772	8.45388	.02844	8.46489	.02917	8.47575	.02991	20
41	.43163	.02702	.44292	.02773	.45407	.02845	.46507	.02918	.47593	.02992	19
42	.43181	.02703	.44311	.02774	.45425	.02846	.46525	.02919	.47611	.02993	18
43	.43200	.02704	.44330	.02775	.45444	.02847	.46544	.02920	.47629	.02994	17
+ 11′	8.43219	.02705	8.44348	.02776	8.45462	.02849	8.46562	.02922	8.47647	.02996	16
45	.43238	.02706	.44367	.02778	.45481	.02850	.46580	.02923	.47665	.02997	15
46	.43257	.02708	.44386	.02779	.45499	.02851	.46598	.02924	.47683	.02998	14
47	.43276	.02709	.44404	.02780	.45518	.02852	.46616	.02925	.47701	.02999	13
+ 12′	8.43295	.02710	8.44423	.02781	8.45536	.02853	8.46634	.02926	8.47719	.03000	12
49	.43314	.02711	.44442	.02782	.45554	.02855	.46653	.02928	.47737	.03002	11
50	.43333	.02712	.44460	.02784	.45573	.02856	.46671	.02929	.47755	.03003	10
51	.43352	.02713	.44479	.02785	.45591	.02857	.46689	.02930	.47773	.03004	9
+ 13′	8.43371	.02715	8.44498	.02786	8.45610	.02858	8.46707	.02931	8.47791	.03005	8
53	.43390	.02716	.44516	.02787	.45628	.02859	.46725	.02933	.47809	.03007	7
54	.43409	.02717	.44535	.02788	.45646	.02861	.46744	.02934	.47827	.03008	6
55	.43427	.02718	.44554	.02790	.45665	.02862	.46762	.02935	.47844	.03009	5
+ 14′	8.43446	.02719	8.44572	.02791	8.45683	.02863	8.46780	.02936	8.47862	.03010	4
57	.43465	.02721	.44591	.02792	.45702	.02864	.46798	.02938	.47880	.03012	3
58	.43484	.02722	.44610	.02793	.45720	.02866	.46816	.02939	.47898	.03013	2
59	.43503	.02723	.44628	.02794	.45738	.02867	.46834	.02940	.47916	.03014	1
+ 15′	8.43522	.02724	8.44647	.02796	8.45757	.02868	8.46852	.02941	8.47934	.03015	0
	$22^h\,44^m$		$22^h\,43^m$		$22^h\,42^m$		$22^h\,41^m$		$22^h\,40^m$		

TABLE 45.

Haversines.

	$1^h 25^m$ 21° 15′		$1^h 26^m$ 21° 30′		$1^h 27^m$ 21° 45′		$1^h 28^m$ 22° 0′		$1^h 29^m$ 22° 15′		
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	s
0	8.53143	.03400	8.54147	.03479	8.55139	.03560	8.56120	.03641	8.57089	.03723	60
1	.53160	.03401	.54164	.03480	.55156	.03561	.56136	.03642	.57105	.03724	59
2	.53177	.03402	.54180	.03482	55172	.03562	.56152	.03644	.57121	.03726	58
3	.53193	.03404	.54197	.03483	.55189	.03564	.56169	.03645	.57137	.03727	57
+ 1′	8.53210	.03405	8.54214	.03484	8.55205	.03565	8.56185	.03646	8.57153	.03728	56
5	.53227	.03406	.54230	.03486	.55221	.03566	.56201	.03648	.57169	.03730	55
6	.53244	.03408	.54247	.03487	55238	.03568	.56217	.03649	.57185	.03731	54
7	.53261	.03409	.54263	.03488	.55254	.03569	.56233	.03650	.57201	.03733	53
+ 2′	8.53277	.03410	8.54280	.03490	8.55271	.03570	8.56250	.03652	8.57217	.03734	52
9	.53294	.03411	.54297	.03491	.55287	.03572	.56266	.03653	.57233	.03735	51
10	.53311	.03413	.54313	.03492	.55303	.03573	.56282	.03654	.57230	.03737	50
11	.53328	.03414	.54330	.03494	.55320	.03574	.56298	.03656	.57266	.03738	49
+ 3′	8.53345	.03415	8.54346	.03495	8.55336	.03576	8.56315	.03657	8.57282	.03740	48
13	.53361	.03417	.54363	.03496	.55353	.03577	.56331	.03659	.57298	.03741	47
14	.53378	.03418	.54380	.03498	.55369	.03578	.56347	.03660	.57314	.03742	46
15	.53395	.03419	.54396	.03499	.55385	.03580	.56363	.03661	.57330	.03744	45
+ 4′	8.53412	.03421	8.54413	.03500	8.55402	.03581	8.56379	.03663	8.57346	.03745	44
17	.53429	.03422	.54429	.03502	.55418	.03582	.56396	.03664	.57362	.03746	43
18	.53445	.03423	.54446	.03503	.55435	.03584	.56412	.03665	.57378	.03748	42
19	.53462	.03425	.54462	.03504	.55451	.03585	.56428	.03667	.57394	.03749	41
+ 5′	8.53479	.03426	8.54479	.03506	8.55467	.03587	8.56444	.03668	8.57410	.03751	40
21	.53496	.03427	.54496	.03507	.55484	.03588	.56460	.03669	.57426	.03752	39
22	.53512	.03429	.54512	.03509	.55500	.03589	.56477	.03671	.57442	.03753	38
23	.53529	.03430	.54529	.03510	.55516	.03591	.56493	.03672	.57458	.03755	37
+ 6′	8.53546	.03431	8.54545	.03511	8.55533	.03592	8.56509	.03674	8.57474	.03756	36
25	.53563	.03433	.54562	.03513	.55549	.03593	.56525	.03675	.57490	.03757	35
26	.53580	.03434	.54578	.03514	.55566	.03595	.56541	.03676	.57506	.03759	34
27	.53596	.03435	.54595	.03515	.55582	.03596	.56557	.03678	.57522	.03760	33
+ 7′	8.53613	.03437	8.54612	.03517	8.55598	.03597	8.56574	.03679	8.57538	.03762	32
29	.53630	.03438	.54628	.03518	.55615	.03599	.56590	.03680	.57554	.03763	31
30	.53646	.03439	.54645	.03519	.55631	.03600	.56606	.03682	.57570	.03764	30
31	.53663	.03441	.54661	.03521	.55647	.03601	.56622	.03683	.57585	.03766	29
+ 8′	8.53680	.03442	8.54678	.03522	8.55664	.03603	8.56638	.03685	8.57601	.03767	28
33	.53697	.03443	.54694	.03523	.55680	.03604	.56654	.03686	.57617	.03769	27
34	.53713	.03445	.54711	.03525	.55696	.03605	.56670	.03687	.57633	.03770	26
35	.53730	.03446	.54727	.03526	.55713	.03607	.56687	.03689	.57649	.03771	25
+ 9′	8.53747	.03447	8.54744	.03527	8.55729	.03608	8.56703	.03690	8.57665	.03773	24
37	.53764	.03449	.54760	.03529	.55745	.03610	.56719	.03691	.57681	.03774	23
38	.53780	.03450	.54777	.03530	.55762	.03611	.56735	.03693	.57697	.03775	22
39	.53797	.03451	.54793	.03531	.55778	.03612	.56751	.03694	.57713	.03777	21
+ 10′	8.53814	.03453	8.54810	.03533	8.55794	.03614	8.56767	.03695	8.57729	.03778	20
41	.53830	.03454	.54826	.03534	.55811	.03615	.56783	.03697	.57745	.03780	19
42	.53847	.03455	.54843	.03535	.55827	.03616	.56799	.03698	.57761	.03781	18
43	.53864	.03457	.54859	.03537	.55843	.03618	.56816	.03700	.57777	.03782	17
+ 11′	8.53880	.03458	8.54876	.03538	8.55859	.03619	8.56832	.03701	8.57793	.03784	16
45	.53897	.03459	.54892	.03539	.55876	.03620	.56848	.03702	.57809	.03785	15
46	.53914	.03460	.54909	.03541	.55892	.03622	.56864	.03704	.57825	.03787	14
47	.53930	.03462	.54925	.03542	.55908	.03623	.56880	.03705	.57841	.03788	13
+ 12′	8.53947	.03463	8.54942	.03543	8.55925	.03624	8.56896	.03706	8.57856	.03789	12
49	.53964	.03464	.54958	.03545	55941	.03626	.56912	.03708	.57872	.03791	11
50	.53980	.03466	.54975	.03546	.55957	.03627	56928	.03709	.57888	.03792	10
51	.53997	.03467	.54991	.03547	.55973	.03629	.56944	.03711	.57904	.03794	9
+ 13′	8.54014	.03468	8.55008	.03549	8.55990	.03630	8.56960	.03712	8.57920	.03795	8
53	.54030	.03470	.55024	.03550	56006	.03631	56977	.03713	.57936	.03796	7
54	.54047	.03471	.55041	.03551	.56022	.03633	.56993	.03715	57952	.03798	6
55	.45064	.03472	.55057	.03553	.56039	.03634	.57009	.03716	.57968	.03799	5
+ 14′	8.54080	.03474	8.55073	.03554	8.56055	.03635	8.57025	.03717	8.57984	.03800	4
57	.54097	.03475	.55090	.03555	.56071	.03637	.57041	.03719	.58000	.03802	3
58	.54114	.03476	.55106	.03557	.56087	.03638	.57057	.03720	.58015	.03803	2
59	.54130	.03478	.55123	.03558	.56104	.03639	.57073	.03722	.58031	.03805	1
+ 15′	8.54147	.03479	8.55139	.03560	8.56120	.03641	8.57089	.03723	8.58047	.03806	0
	$22^h 34^m$		$22^h 33^m$		$22^h 32^m$		$22^h 31^m$		$22^h 30^m$		

TABLE 45.

Haversines.

s	$1^{h}\ 35^{m}$ 23° 45′		$1^{h}\ 36^{m}$ 24° 0′		$1^{h}\ 37^{m}$ 24° 15′		$1^{h}\ 38^{m}$ 24° 30′		$1^{h}\ 39^{m}$ 24° 45′		s
	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	
0	8.62680	.04234	8.63576	.04323	8.64463	.04412	8.65340	.04502	8.66208	.04593	60
1	.62695	.04236	.63591	.04324	.64477	.04413	.65355	.04503	.66223	.04594	59
2	.62710	.04237	.63606	.04326	.64492	.04415	.65369	.04505	.66237	.04596	58
3	.62725	.04239	.63620	.04327	.64507	.04416	.65384	.04506	.66251	.04597	57
+ 1′	8.62740	.04240	8.63635	.04329	8.64521	.04418	8.65398	.04508	8.66266	.04599	56
5	.62755	.04242	.63650	.04330	.64536	.04419	.65413	.04509	.66280	.04600	55
6	.62770	.04243	.63665	.04332	.64551	.04421	.65427	.04511	.66295	.04602	54
7	.62785	.04245	.63680	.04333	.64565	.04422	.65442	.04512	.66309	.04604	53
+ 2′	8.62800	.04246	8.63695	.04335	8.64580	.04424	8.65456	.04514	8.66323	.04605	52
9	.62815	.04248	.63709	.04336	.64595	.04425	.65471	.04516	.66338	.04607	51
10	.62830	.04249	.63724	.04338	.64609	.04427	.65485	.04517	.66352	.04608	50
11	.62845	.04251	.63739	.04339	.64624	.04428	.65500	.04519	.66366	.04610	49
+ 3′	8.62860	.04252	8.63754	.04340	8.64639	.04430	8.65514	.04520	8.66381	.04611	48
13	.62875	.04253	.63769	.04342	.64653	.04431	.65529	.04522	.66395	.04613	47
14	.62890	.04255	.63784	.04343	.64668	.04433	.65543	.04523	.66409	.04614	46
15	.62904	.04256	.63798	.04345	.64683	.04434	.65558	.04525	.66424	.04616	45
+ 4′	8.62919	.04258	8.63813	.04346	8.64697	.04436	8.65572	.04526	8.66438	.04617	44
17	.62934	.04259	.63828	.04348	.64712	.04437	.65587	.04528	.66453	.04619	43
18	.62949	.04261	.63843	.04349	.64727	.04439	.65601	.04529	.66467	.04620	42
19	.62964	.04262	.63858	.04351	.64741	.04440	.65616	.04531	.66481	.04622	41
+ 5′	8.62979	.04264	8.63872	.04352	8.64756	.04442	8.65630	.04532	8.66496	.04623	40
21	.62994	.04265	.63887	.04354	.64771	.04443	.65645	.04534	.66510	.04625	39
22	.63009	.04267	.63902	.04355	.64785	.04445	.65659	.04535	.66524	.04626	38
23	.63024	.04268	.63917	.04357	.64800	.04446	.65674	.04537	.66539	.04628	37
+ 6′	8.63039	.04270	8.63932	.04358	8.64815	.04448	8.65688	.04538	8.66553	.04629	36
25	.63054	.04271	.63946	.04360	.64829	.04449	.65703	.04540	.66567	.04631	35
26	.63069	.04273	.63961	.04361	.64844	.04451	.65717	.04541	.66582	.04633	34
27	.63084	.04274	.63976	.04363	.64859	.04452	.65732	.04543	.66596	.04634	33
+ 7′	8.63099	.04276	8.63991	.04364	8.64873	.04454	8.65746	.04544	8.66610	.04636	32
29	.63114	.04277	.64006	.04366	.64888	.04455	.65761	.04546	.66625	.04637	31
30	.63129	.04278	.64020	.04367	.64902	.04457	.65775	.04547	.66639	.04638	30
31	.63144	.04280	.64035	.04369	.64917	.04458	.65790	.04549	.66653	.04640	29
+ 8′	8.63159	.04281	8.64050	.04370	8.64932	.04460	8.65804	.04550	8.66668	.04642	28
33	.63174	.04283	.64065	.04372	.64946	.04461	.65819	.04552	.66682	.04643	27
34	.63189	.04284	.64079	.04373	.64961	.04463	.65833	.04553	.66696	.04645	26
35	.63204	.04286	.64094	.04375	.64976	.04464	.65848	.04555	.66710	.04646	25
+ 9′	8.63218	.04287	8.64109	.04376	8.64990	.04466	8.65862	.04556	8.66725	.04648	24
37	.63233	.04289	.64124	.04378	.65005	.04467	.65876	.04558	.66739	.04649	23
38	.63248	.04290	.64139	.04379	.65019	.04469	.65891	.04559	.66753	.04651	22
39	.63263	.04292	.64153	.04381	.65034	.04470	.65905	.04561	.66768	.04652	21
+ 10′	8.63278	.04293	8.64168	.04382	8.65049	.04472	8.65920	.04562	8.66782	.04654	20
41	.63293	.04295	.64183	.04384	.65063	.04473	.65934	.04564	.66796	.04655	19
42	.63308	.04296	.64198	.04385	.65078	.04475	.65949	.04565	.66811	.04657	18
43	.63323	.04298	.64212	.04387	.65092	.04476	.65963	.04567	.66825	.04659	17
+ 11′	8.63338	.04299	8.64227	.04388	8.65107	.04478	8.65978	.04569	8.66839	.04660	16
45	.63353	.04301	.64242	.04390	.65122	.04479	.65992	.04570	.66853	.04662	15
46	.63368	.04302	.64257	.04391	.65136	.04481	.66006	.04572	.66868	.04663	14
47	.63382	.04304	.64271	.04393	.65151	.04482	.66021	.04573	.66882	.04665	13
+ 12′	8.63397	.04305	8.64286	.04394	8.65165	.04484	8.66035	.04575	8.66896	.04666	12
49	.63412	.04306	.64301	.04395	.65180	.04485	.66050	.04576	.66911	.04668	11
50	.63427	.04308	.64315	.04397	.65194	.04487	.66064	.04578	.66925	.04669	10
51	.63442	.04309	.64330	.04398	.65209	.04488	.66079	.04579	.66939	.04671	9
+ 13′	8.63457	.04311	8.64345	.04400	8.65224	.04490	8.66093	.04581	8.66953	.04672	8
53	.63472	.04312	.64360	.04401	.65238	.04491	.66107	.04582	.66968	.04674	7
54	.63487	.04314	.64374	.04403	.65253	.04493	.66122	.04584	.66982	.04675	6
55	.63502	.04315	.64389	.04404	.65267	.04494	.66136	.04585	.66996	.04677	5
+ 14′	8.63516	.04317	8.64404	.04405	8.65282	.04496	8.66151	.04587	8.67010	.04678	4
57	.63531	.04318	.64418	.04407	.65296	.04497	.66165	.04588	.67025	.04680	3
58	.63546	.04320	.64433	.04409	.65311	.04499	.66179	.04590	.67039	.04682	2
59	.63561	.04321	.64448	.04410	.65325	.04500	.66194	.04591	.67053	.04683	1
+ 15′	8.63576	.04323	8.64463	.04412	8.65340	.04502	8.66208	.04593	8.67067	.04685	0
	$22^{h}\ 24^{m}$		$22^{h}\ 23^{m}$		$22^{h}\ 22^{m}$		$22^{h}\ 21^{m}$		$22^{h}\ 20^{m}$		

TABLE 45.

Haversines.

	1h 40m 25° 0′		1h 41m 25° 15′		1h 42m 25° 30′		1h 43
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Ha
0	8.67067	.04685	8.67918	.04777	8.68760	.04871	8.6959
1	.67082	.04686	.67932	.04779	.68773	.04872	.6960
2	.67096	.04688	.67946	.04780	.68787	.04874	.6962
3	.67110	.04689	.67960	.04782	.68801	.04875	.6963
+ 1′	8.67124	.04691	8.67974	.04783	8.68815	.04877	8.6964
5	.67139	.04692	.67988	.04785	.68829	.04879	.6966
6	.67153	.04694	.68002	.04787	.68843	.04880	.6967
7	.67167	.04695	.68016	.04788	.68857	.04882	.6969
+ 2′	8.67181	.04697	8.68030	.04790	8.68871	.04883	8.6970
9	.67196	.04698	.68045	.04791	.68885	.04885	.6971
10	.67210	.04700	.68059	.04793	.68899	.04886	.6973
11	.67224	.04702	.68073	.04794	.68913	.04888	.6974
+ 3′	8.67238	.04703	8.68087	.04796	8.68927	.04890	8.6975
13	.67252	.04705	.68101	.04797	.68941	.04891	.6977
14	.67267	.04706	.68115	.04799	.68955	.04893	.6978
15	.67281	.04708	.68129	.04801	.68969	.04894	.6980
+ 4′	8.67295	.04709	8.68143	.04802	8.68983	.04896	8.6981
17	.67309	.04711	.68157	.04804	.68996	.04897	.6982
18	.67323	.04712	.68171	.04805	.69010	.04899	.6984
19	.67338	.04714	.68185	.04807	.69024	.04901	.6985
+ 5′	8.67352	.04715	8.68199	.04808	8.69038	.04902	8.6986
21	.67366	.04717	.68213	.04810	.69052	.04904	.6988
22	.67380	.04718	.68227	.04811	.69066	.04905	.6989
23	.67394	.04720	.68241	.04813	.69080	.04907	.6991
+ 6′	8.67409	.04722	8.68256	.04815	8.69094	.04908	8.6992
25	.67423	.04723	.68270	.04816	.69108	.04910	.6993
26	.67437	.04725	.68284	.04818	.69122	.04912	.6995
27	.67451	.04726	.68298	.04819	.69136	.04913	.6996
+ 7′	8.67465	.04728	8.68312	.04821	8.69149	.04915	8.6997
29	.67480	.04729	.68326	.04822	.69163	.04916	.6999
30	.67494	.04731	.68340	.04824	.69177	.04918	.7000
31	.67508	.04732	.68354	.04825	.69191	.04919	.7002
+ 8′	8.67522	.04734	8.68368	.04827	8.69205	.04921	8.70034
33	.67536	.04735	.68382	.04829	.69219	.04923	.70047
34	.67550	.04737	.68396	.04830	.69233	.04924	.70061
35	.67565	.04739	.68410	.04832	.69247	.04926	.70075
+ 9′	8.67579	.04740	8.68424	.04833	8.69260	.04927	8.7008
37	.67593	.04742	.68438	.04835	.69274	.04929	.70102
38	.67607	.04743	.68452	.04836	.69288	.04930	.7011
39	.67621	.04745	.68466	.04838	.69302	.04932	.7013
+ 10′	8.67635	.04746	8.68480	.04839	8.69316	.04934	8.70144
41	.67649	.04748	.68494	.04841	.69330	.04935	.70157
42	.67664	.04749	.68508	.04843	.69344	.04937	.70171
43	.67678	.04751	.68522	.04844	.69358	.04938	.70185
+ 11′	8.67692	.04752	8.68536	.04846	8.69371	.04940	8.7019
45	.67706	.04754	.68550	.04847	.69385	.04941	.70212
46	.67720	.04756	.68564	.04849	.69399	.04943	.7022
47	.67734	.04757	.68578	.04850	.69413	.04945	.7024
+ 12′	8.67748	.04759	8.68592	.04852	8.69427	.04946	8.7025
49	.67763	.04760	.68606	.04854	.69441	.04948	.70267
50	.67777	.04762	.68620	.04855	.69454	.04949	.70281
51	.67791	.04763	.68634	.04857	.69468	.04951	.70294
+ 13′	8.67805	.04765	8.68648	.04858	8.69482	.04952	8.7030
53	.67819	.04766	.68662	.04860	.69496	.04954	.70322
54	.67833	.04768	.68676	.04861	.69510	.04956	.7033
55	.67847	.04769	.68690	.04863	.69524	.04957	.7034
+ 14′	8.67861	.04771	8.68704	.04864	8.69537	.04959	8.70363
57	.67875	.04773	.68718	.04866	.69551	.04960	.70377
58	.67890	.04774	.68732	.04868	.69565	.04962	.70390
59	.67904	.04776	.68746	.04869	.69579	.04964	.70404
+ 15′	8.67918	.04777	8.68760	.04871	8.69593	.04965	8.70418
	22h 19m		22h 18m		22h 17m		22

TABLE 45.

Haversines.

s	$1^h\ 45^m$ 26° 15′		$1^h\ 46^m$ 26° 30′		$1^h\ 47^m$ 26° 45′		$1^h\ 48^m$ 27° 0′		$1^h\ 49^m$ 27° 15′		s
	Log. Hav.	Nat. Hav.	Log. Hav	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	
0	8.71234	**.05156**	8.72043	**.05253**	8.72844	**.05351**	8.73637	**.05450**	8.74423	**.05549**	60
1	.71248	**.05158**	.72057	**.05255**	.72857	**.05353**	.73650	**.05451**	.74436	**.05551**	59
2	.71261	**.05160**	.72070	**.05257**	.72871	**.05354**	.73663	**.05453**	.74449	**.05552**	58
3	.71275	**.05161**	.72083	**.05258**	.72884	**.05356**	.73677	**.05455**	.74462	**.05554**	57
+ 1′	8.71289	**.05163**	8.72097	**.05260**	8.72897	**.05358**	8.73690	**.05456**	8.74475	**.05556**	56
5	.71302	**.05164**	.72110	**.05261**	.72910	**.05359**	.73703	**.05458**	.74488	**.05557**	55
6	.71316	**.05166**	.72124	**.05263**	.72924	**.05361**	.73716	**.05460**	.74501	**.05559**	54
7	.71329	**.05168**	.72137	**.05265**	.72937	**.05363**	.73729	**.05461**	.74514	**.05561**	53
+ 2′	8.71343	**.05169**	8.72150	**.05266**	8.72950	**.05364**	8.73742	**.05463**	8.74527	**.05562**	52
9	.71356	**.05171**	.72164	**.05268**	.72963	**.05366**	.73755	**.05464**	.74540	**.05564**	51
10	.71370	**.05172**	.72177	**.05270**	.72977	**.05367**	.73769	**.05466**	.74553	**.05566**	50
11	.71383	**.05174**	.72191	**.05271**	.72990	**.05369**	.73782	**.05468**	.74566	**.05567**	49
+ 3′	8.71397	**.05176**	8.72204	**.05273**	8.73003	**.05371**	8.73795	**.05470**	8.74579	**.05569**	48
13	.71410	**.05177**	.72217	**.05274**	.73016	**.05372**	.73808	**.05471**	.74592	**.05571**	47
14	.71424	**.05179**	.72231	**.05276**	.73030	**.05374**	.73821	**.05473**	.74605	**.05572**	46
15	.71437	**.05181**	.72244	**.05278**	.73043	**.05376**	.73834	**.05474**	.74618	**.05574**	45
+ 4′	8.71451	**.05182**	8.72257	**.05279**	8.73056	**.05377**	8.73847	**.05476**	8.74631	**.05576**	44
17	.71464	**.05184**	.72271	**.05281**	.73069	**.05379**	.73860	**.05478**	.74644	**.05577**	43
18	.71478	**.05185**	.72284	**.05283**	.73083	**.05381**	.73874	**.05479**	.74657	**.05579**	42
19	.71491	**.05187**	.72298	**.05284**	.73096	**.05382**	.73887	**.05481**	.74670	**.05581**	41
+ 5′	8.71505	**.05189**	8.72311	**.05286**	8.73109	**.05384**	8.73900	**.05483**	8.74683	**.05582**	40
21	.71518	**.05190**	.72324	**.05287**	.73122	**.05385**	.73913	**.05484**	.74696	**.05584**	39
22	.71532	**.05192**	.72338	**.05289**	.73136	**.05387**	.73926	**.05486**	.74709	**.05586**	38
23	.71545	**.05193**	.72351	**.05291**	.73149	**.05389**	.73939	**.05488**	.74722	**.05587**	37
+ 6′	8.71559	**.05195**	8.72364	**.05292**	8.73162	**.05390**	8.73952	**.05489**	8.74735	**.05589**	36
25	.71572	**.05197**	.72378	**.05294**	.73175	**.05392**	.73965	**.05491**	.74748	**.05591**	35
26	.71586	**.05198**	.72391	**.05296**	.73189	**.05394**	.73978	**.05493**	.74761	**.05593**	34
27	.71599	**.05200**	.72404	**.05297**	.73202	**.05395**	.73992	**.05494**	.74774	**.05594**	33
+ 7′	8.71613	**.05201**	8.72418	**.05299**	8.73215	**.05397**	8.74005	**.05496**	8.74787	**.05596**	32
29	.71626	**.05203**	.72431	**.05300**	.73228	**.05399**	.74018	**.05498**	.74800	**.05597**	31
30	.71640	**.05205**	.72445	**.05302**	.73241	**.05400**	.74031	**.05499**	.74813	**.05599**	30
31	.71653	**.05206**	.72458	**.05304**	.73255	**.05402**	.74044	**.05501**	.74826	**.05601**	29
+ 8′	8.71667	**.05208**	8.72471	**.05305**	8.73268	**.05404**	8.74057	**.05503**	8.74839	**.05603**	28
33	.71680	**.05210**	.72485	**.05307**	.73281	**.05405**	.74070	**.05504**	.74852	**.05604**	27
34	.71694	**.05211**	.72498	**.05309**	.73294	**.05407**	.74083	**.05506**	.74864	**.05606**	26
35	.71707	**.05213**	.72511	**.05310**	.73308	**.05408**	.74096	**.05508**	.74877	**.05607**	25
+ 9′	8.71721	**.05214**	8.72525	**.05312**	8.73321	**.05410**	8.74109	**.05509**	8.74890	**.05609**	24
37	.71734	**.05216**	.72538	**.05314**	.73334	**.05412**	.74122	**.05511**	.74903	**.05611**	23
38	.71748	**.05218**	.72551	**.05315**	.73347	**.05413**	.74135	**.05513**	.74916	**.05613**	22
39	.71761	**.05219**	.72565	**.05317**	.73360	**.05415**	.74149	**.05514**	.74929	**.05614**	21
+ 10′	8.71774	**.05221**	8.72578	**.05318**	8.73374	**.05417**	8.74162	**.05516**	8.74942	**.05616**	20
41	.71788	**.05222**	.72591	**.05320**	.73387	**.05418**	.74175	**.05518**	.74955	**.05618**	19
42	.71801	**.05224**	.72605	**.05322**	.73400	**.05420**	.74188	**.05519**	.74968	**.05619**	18
43	.71815	**.05226**	.72618	**.05323**	.73413	**.05422**	.74201	**.05521**	.74981	**.05621**	17
+ 11′	8.71828	**.05227**	8.72631	**.05325**	8.73426	**.05423**	8.74214	**.05523**	8.74994	**.05623**	16
45	.71842	**.05229**	.72644	**.05326**	.73440	**.05425**	.74227	**.05524**	.75007	**.05624**	15
46	.71855	**.05231**	.72658	**.05328**	.73453	**.05427**	.74240	**.05526**	.75020	**.05626**	14
47	.71869	**.05232**	.72671	**.05330**	.73466	**.05428**	.74253	**.05528**	.75033	**.05628**	13
+ 12′	8.71882	**.05234**	8.72684	**.05331**	8.73479	**.05430**	8.74266	**.05529**	8.75046	**.05629**	12
49	.71895	**.05235**	.72698	**.05333**	.73492	**.05431**	.74279	**.05531**	.75059	**.05631**	11
50	.71909	**.05237**	.72711	**.05335**	.73505	**.05433**	.74292	**.05533**	.75072	**.05633**	10
51	.71922	**.05239**	.72724	**.05336**	.73519	**.05435**	.74305	**.05534**	.75084	**.05634**	9
+ 13′	8.71936	**.05240**	8.72738	**.05338**	8.73532	**.05436**	8.74318	**.05536**	8.75097	**.05636**	8
53	.71949	**.05242**	.72751	**.05340**	.73545	**.05438**	.74331	**.05537**	.75110	**.05638**	7
54	.71963	**.05244**	.72764	**.05341**	.73558	**.05440**	.74344	**.05539**	.75123	**.05639**	6
55	.71976	**.05245**	.72778	**.05343**	.73571	**.05441**	.74357	**.05541**	.75136	**.05641**	5
+ 14′	8.71989	**.05247**	8.72791	**.05345**	8.73584	**.05443**	8.74371	**.05542**	8.75149	**.05643**	4
54	.72003	**.05248**	.72804	**.05346**	.73598	**.05445**	.74384	**.05544**	.75162	**.05644**	3
58	.72016	**.05250**	.72817	**.05348**	.73611	**.05446**	.74397	**.05546**	.75175	**.05646**	2
59	.72030	**.05252**	.72831	**.05349**	.73624	**.05448**	.74410	**.05547**	.75188	**.05648**	1
+ 15′	8.72043	**.05253**	8.72844	**.05351**	8.73637	**.05450**	8.74423	**.05549**	8.75201	**.05649**	0
	$22^h\ 14^m$		$22^h\ 13^m$		$22^h\ 12^m$		$22^h\ 11^m$		$22^h\ 10^m$		

TABLE 45.

Haversines.

	$1^h\ 50^m$ 27° 30′		$1^h\ 51^m$ 27° 45′		$1^h\ 52^m$ 28° 0′		$1^h\ 53^m$ 2	
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	N
0	8.75201	**.05649**	8.75972	**.05751**	8.76735	**.05853**	8.77492	
1	.75214	**.05651**	.75984	**.05752**	.76748	**.05854**	.77504	
2	.75227	**.05653**	.75997	**.05754**	.76760	**.05856**	.77517	
3	.75239	**.05655**	.76010	**.05756**	.76773	**.05858**	.77529	
+ 1′	8.75252	**.05656**	8.76023	**.05757**	8.76786	**.05859**	8.77542	
5	.75265	**.05658**	.76035	**.05759**	.76798	**.05861**	.77554	
6	.75278	**.05660**	.76048	**.05761**	76811	**.05863**	.77567	
7	.75291	**.05661**	.76061	**.05762**	.76824	**.05865**	.77579	
+ 2′	8.75304	**.05663**	8.76074	**.05764**	8.76836	**.05866**	8.77592	
9	.75317	**.05665**	.76086	**.05766**	.76849	**.05868**	.77604	
10	.75330	**.05666**	.76099	**.05768**	.76862	**.05870**	.77617	
11	.75343	**.05668**	.76112	**.05769**	.76874	**.05871**	.77630	
+ 3′	8.75355	**.05670**	8.76125	**.05771**	8.76887	**.05873**	8.77642	
13	.75368	**.05671**	.76138	**.05773**	.76900	**.05875**	.77655	
14	.75381	**.05673**	.76150	**.05774**	.76912	**.05877**	.77667	
15	.75394	**.05675**	.76163	**.05776**	.76925	**.05878**	.77680	
+ 4′	8.75407	**.05676**	8.76176	**.05778**	8.76938	**.05880**	8.77692	
17	.75420	**.05678**	.76189	**.05779**	.76950	**.05882**	.77705	
18	.75433	**.05680**	.76201	**.05781**	.76963	**.05883**	.77717	
19	.75446	**.05681**	.76214	**.05783**	.76975	**.05885**	.77730	
+ 5′	8.75458	**.05683**	8.76227	**.05785**	8.76988	**.05887**	8.77742	
21	.75471	**.05685**	.76240	**.05786**	.77001	**.05888**	.77755	
22	.75484	**.05686**	.76252	**.05788**	.77013	**.05890**	.77767	
23	.75497	**.05688**	.76265	**.05790**	.77026	**.05892**	.77780	
+ 6′	8.75510	**.05690**	8.76278	**.05791**	8.77039	**.05894**	8.77792	
25	.75523	**.05691**	.76291	**.05793**	.77051	**.05895**	.77805	
26	.75536	**.05693**	.76303	**.05795**	.77064	**.05897**	.77817	
27	.75548	**.05695**	.76316	**.05796**	.77076	**.05899**	.77830	
+ 7′	8.75561	**.05697**	8.76329	**.05798**	8.77089	**.05901**	8.77842	
29	.75574	**.05698**	.76341	**.05800**	.77102	**.05902**	.77855	
30	.75587	**.05700**	.76354	**.05802**	.77114	**.05904**	.77867	
31	.75600	**.05702**	.76367	**.05803**	.77127	**.05906**	.77880	
+ 8′	8.75613	**.05703**	8.76380	**.05805**	8.77139	**.05907**	8.77892	
33	.75626	**.05705**	.76392	**.05807**	.77152	**.05909**	.77905	
34	.75638	**.05707**	.76405	**.05808**	.77165	**.05911**	.77917	
35	.75651	**.05708**	.76418	**.05810**	.77177	**.05913**	.77930	
+ 9′	8.75664	**.05710**	8.76431	**.05812**	8.77190	**.05914**	8.77942	
37	.75677	**.05712**	.76443	**.05813**	.77202	**.05916**	.77955	
38	.75690	**.05713**	.76456	**.05815**	.77215	**.05918**	.77967	
39	.75703	**.05715**	.76469	**.05817**	.77228	**.05919**	.77980	
+ 10′	8.75715	**.05717**	8.76481	**.05819**	8.77240	**.05921**	8.77992	
41	.75728	**.05718**	.76494	**.05820**	.77253	**.05923**	.78005	
42	.75741	**.05720**	.76507	**.05822**	.77265	**.05925**	.78017	
43	.75754	**.05722**	.76519	**.05824**	.77278	**.05926**	.78029	
+ 11′	8.75767	**.05724**	8.76532	**.05825**	8.77291	**.05928**	8.78042	
45	.75779	**.05725**	.76545	**.05827**	.77303	**.05930**	.78054	
46	.75792	**.05727**	.76558	**.05829**	.77316	**.05931**	.78067	
47	.75805	**.05729**	.76570	**.05830**	.77328	**.05933**	.78079	
+ 12′	8.75818	**.05730**	8.76583	**.05832**	8.77341	**.05935**	8.78092	
49	.75831	**.05732**	.76596	**.05834**	.77353	**.05936**	.78104	
50	.75844	**.05734**	.76608	**.05836**	.77366	**.05938**	.78117	
51	.75856	**.05735**	.76621	**.05837**	.77379	**.05940**	.78129	
+ 13′	8.75869	**.05737**	8.76634	**.05839**	8.77391	**.05942**	8.78142	
53	.75882	**.05739**	.76646	**.05841**	.77404	**.05943**	.78154	
54	.75895	**.05740**	.76659	**.05842**	.77416	**.05945**	.78167	
55	.75908	**.05742**	.76672	**.05844**	.77429	**.05947**	.78179	
+ 14′	8.75920	**.05744**	8.76684	**.05846**	8.77441	**.05949**	8.78191	
57	.75933	**.05745**	.76697	**.05847**	.77454	**.05950**	.78204	
58	.75946	**.05747**	.76710	**.05849**	.77466	**.05952**	.78216	
59	.75959	**.05749**	.76722	**.05851**	.77479	**.05954**	.78229	
+ 15′	8.75972	**.05751**	8.76735	**.05853**	8.77492	**.05955**	8.78241	
	$22^h\ 9^m$		$22^h\ 8^m$		$22^h\ 7^m$		$22^h\ 6$	

TABLE 45.

Haversines.

s	$1^h 55^m$ 28° 45′		$1^h 56^m$ 29° 0′		$1^h 57^m$ 29° 15′		$1^h 58^m$ 29° 30′		$1^h 59^m$ 29° 45′		s
	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	
0	8.78984	**.06164**	8.79720	**.06269**	8.80449	**.06375**	8.81172	**.06482**	8.81889	**.06590**	*60*
1	.78996	**.06165**	.79732	**.06271**	.80462	**.06377**	.81184	**.06484**	.81901	**.06592**	*59*
2	.79009	**.06167**	.79744	**.06273**	.80474	**.06379**	.81196	**.06486**	.81913	**.06594**	*58*
3	.79021	**.06169**	.79757	**.06274**	.80486	**.06381**	.81208	**.06488**	.81925	**.06595**	*57*
+ 1′	8.79033	**.06171**	8.79769	**.06276**	8.80498	**.06382**	8.81220	**.06489**	8.81937	**.06597**	*56*
5	.79046	**.06172**	~~.79781~~	~~**.06278**~~	.80510	**.06384**	.81232	**.06491**	.81948	**.06599**	*55*
6	.79058	**.06174**	.79793	**.06280**	.80522	**.06386**	.81244	**.06493**	.81960	**.06601**	*54*
7	.79070	**.06176**	.79805	**.06281**	.80534	**.06388**	.81256	**.06495**	.81972	**.06603**	*53*
+ 2′	8.79082	**.06178**	8.79818	**.06283**	8.80546	**.06389**	8.81268	**.06497**	8.81984	**.06605**	*52*
9	.79095	**.06179**	.79830	**.06285**	.80558	**.06391**	.81280	**.06498**	.81996	**.06606**	*51*
10	.79107	**.06181**	.79842	**.06287**	.80570	**.06393**	.81292	**.06500**	.82008	**.06608**	*50*
11	.79119	**.06183**	.79854	**.06288**	.80582	**.06395**	.81304	**.06502**	.82020	**.06610**	*49*
+ 3′	8.79132	**.06185**	8.79866	**.06290**	8.80595	**.06397**	8.81316	**.06504**	8.82032	**.06612**	*48*
13	.79144	**.06186**	.79879	**.06292**	.80607	**.06398**	.81328	**.06505**	.82043	**.06614**	*47*
14	.79156	**.06188**	.79891	**.06294**	.80619	**.06400**	.81340	**.06507**	.82055	**.06615**	*46*
15	.79169	**.06190**	.79903	**.06295**	.80631	**.06402**	.81352	**.06509**	.82067	**.06617**	*45*
+ 4′	8.79181	**.06192**	8.79915	**.06297**	8.80643	**.06404**	8.81364	**.06511**	8.82079	**.06619**	*44*
17	.79193	**.06193**	.79927	**.06299**	.80655	**.06405**	.81376	**.06513**	.82091	**.06621**	*43*
18	.79205	**.06195**	.79940	**.06301**	.80667	**.06407**	.81388	**.06514**	.82103	**.06623**	*42*
19	.79218	**.06197**	.79952	**.06303**	.80679	**.06409**	.81400	**.06516**	.82115	**.06624**	*41*
+ 5′	8.79230	**.06199**	8.79964	**.06304**	8.80691	**.06411**	8.81412	**.06518**	8.82126	**.06626**	*40*
21	.79242	**.06200**	.79976	**.06306**	.80703	**.06413**	.81424	**.06520**	.82138	**.06628**	*39*
22	.79255	**.06202**	.79988	**.06308**	.80715	**.06414**	.81436	**.06522**	.82150	**.06630**	*38*
23	.79267	**.06204**	.80000	**.06310**	.80727	**.06416**	.81448	**.06523**	.82162	**.06632**	*37*
+ 6′	8.79279	**.06206**	8.80013	**.06311**	8.80739	**.06418**	8.81460	**.06525**	8.82174	**.06633**	*36*
25	.79291	**.06207**	.80025	**.06313**	.80751	**.06420**	.81472	**.06527**	.82186	**.06635**	*35*
26	.79304	**.06209**	.80037	**.06315**	.80764	**.06421**	.81484	**.06529**	.82198	**.06637**	*34*
27	.79316	**.06211**	.80049	**.06317**	.80776	**.06423**	.81496	**.06531**	.82209	**.06639**	*33*
+ 7′	8.79328	**.06213**	8.80061	**.06318**	8.80788	**.06425**	8.81508	**.06532**	8.82221	**.06641**	*32*
29	.79341	**.06214**	.80073	**.06320**	.80800	**.06427**	.81520	**.06534**	.82233	**.06642**	*31*
30	.79353	**.06216**	.80086	**.06322**	.80812	**.06429**	.81531	**.06536**	.82245	**.06644**	*30*
31	.79365	**.06218**	.80098	**.06324**	.80824	**.06430**	.81543	**.06538**	.82257	**.06646**	*29*
+ 8′	8.79377	**.06220**	8.80110	**.06326**	8.80836	**.06432**	8.81555	**.06540**	8.82269	**.06648**	*28*
33	.79390	**.06221**	.80122	**.06327**	.80848	**.06434**	.81567	**.06541**	.82280	**.06650**	*27*
34	.79402	**.06223**	.80134	**.06329**	.80860	**.06436**	.81579	**.06543**	.82292	**.06652**	*26*
35	.79414	**.06225**	.80146	**.06331**	.80872	**.06438**	.81591	**.06545**	.82304	**.06653**	*25*
+ 9′	8.79426	**.06227**	8.80158	**.06333**	8.80884	**.06439**	8.81603	**.06547**	8.82316	**.06655**	*24*
37	.79439	**.06229**	.80171	**.06334**	.80896	**.06441**	.81615	**.06549**	.82328	**.06657**	*23*
38	.79451	**.06230**	.80183	**.06336**	.80908	**.06443**	.81627	**.06550**	.82340	**.06659**	*22*
39	.79463	**.06232**	.80195	**.06338**	.80920	**.06445**	.81639	**.06552**	.82351	**.06661**	*21*
+ 10′	8.79475	**.06234**	8.80207	**.06340**	8.80932	**.06446**	8.81651	**.06554**	8.82363	**.06662**	*20*
41	.79488	**.06236**	.80219	**.06341**	.80944	**.06448**	.81663	**.06556**	.82375	**.06664**	*19*
42	.79500	**.06237**	.80231	**.06343**	.80956	**.06450**	.81675	**.06558**	.82387	**.06666**	*18*
43	.79512	**.06239**	.80243	**.06345**	.80968	**.06452**	.81687	**.06559**	.82399	**.06668**	*17*
+ 11′	8.79524	**.06241**	8.80256	**.06347**	8.80980	**.06454**	8.81699	**.06561**	8.82410	**.06670**	*16*
45	.79537	**.06243**	.80268	**.06349**	.80992	**.06455**	.81710	**.06563**	.82422	**.06671**	*15*
46	.79549	**.06244**	.80280	**.06350**	.81004	**.06457**	.81722	**.06565**	.82434	**.06673**	*14*
47	.79561	**.06246**	.80292	**.06352**	.81016	**.06459**	.81734	**.06567**	.82446	**.06675**	*13*
+ 12′	8.79573	**.06248**	8.80304	**.06354**	8.81028	**.06461**	8.81746	**.06568**	8.82458	**.06677**	*12*
49	.79586	**.06250**	.80316	**.06356**	.81040	**.06463**	.81758	**.06570**	.82470	**.06679**	*11*
50	.79598	**.06251**	.80328	**.06357**	.81052	**.06464**	.81770	**.06572**	.82481	**.06681**	*10*
51	.79610	**.06253**	.80340	**.06359**	.81064	**.06466**	.81782	**.06574**	.82493	**.06682**	*9*
+ 13′	8.79622	**.06255**	8.80353	**.06361**	8.81076	**.06468**	8.81794	**.06576**	8.82505	**.06684**	*8*
53	.79634	**.06257**	.80365	**.06363**	.81088	**.06470**	.81806	**.06577**	.82517	**.06686**	*7*
54	.79647	**.06258**	.80377	**.06365**	.81100	**.06471**	.81818	**.06579**	.82529	**.06688**	*6*
55	.79659	**.06260**	.80389	**.06366**	.81112	**.06473**	.81830	**.06581**	.82540	**.06690**	*5*
+ 14′	8.79671	**.06262**	8.80401	**.06368**	8.81124	**.06475**	8.81841	**.06583**	8.82552	**.06691**	*4*
57	.79683	**.06264**	.80413	**.06370**	.81136	**.06477**	.81853	**.06585**	.82564	**.06693**	*3*
58	.79696	**.06265**	.80425	**.06372**	.81148	**.06479**	.81865	**.06586**	.82576	**.06695**	*2*
59	.79708	**.06267**	.80437	**.06373**	.81160	**.06480**	.81877	**.06588**	.82588	**.06697**	*1*
+ 15′	8.79720	**.06269**	8.80449	**.06375**	8.81172	**.06482**	8.81889	**.06590**	8.82599	**.06699**	*0*
	$22^h 4^m$		$22^h 3^m$		$22^h 2^m$		$22^h 1^m$		$22^h 0^m$		

TABLE 45.

Haversines.

	$2^h\,5^m$ 31° 15′		$2^h\,6^m$ 31° 30′		$2^h\,7^m$ 31° 45′		$2^h\,8^m$ 32° 0′		$2^h\,9^m$ 32° 15′		
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	s
0	8.86060	.07254	8.86735	.07368	8.87404	.07482	8.88068	.07598	8.88726	.07714	60
1	.86072	.07256	.86746	.07370	.87415	.07484	.88079	.07600	.88737	.07716	59
2	.86085	.07258	.86757	.07372	.87426	.07486	.88090	.07601	.88748	.07717	58
3	.86094	.07260	.86769	.07374	.87437	.07488	.88101	.07603	.88759	.07719	57
+ 1′	8.86105	.07262	8.86780	.07376	8.87448	.07490	8.88112	.07605	8.88769	.07721	56
5	.86117	.07264	.86791	.07377	.87460	.07492	.88123	.07607	.88780	.07723	55
6	.86128	.07266	.86802	.07379	.87471	.07494	.88134	.07609	.88791	.07725	54
7	.86139	.07268	.86813	.07381	.87482	.07496	.88145	.07611	.88802	.07727	53
+ 2′	8.86151	.07270	8.86825	.07383	8.87493	.07498	8.88156	.07613	8.88813	.07729	52
9	.86162	.07271	.86836	.07385	.87504	.07500	.88167	.07615	.88824	.07731	51
10	.86173	.07273	.86847	.07387	.87515	.07502	.88178	.07617	.88835	.07733	50
11	.86184	.07275	.86858	.07389	.87526	.07503	.88189	.07619	.88846	.07735	49
+ 3′	8.86196	.07277	8.86869	.07391	8.87537	.07505	8.88200	.07621	8.88857	.07737	48
13	.86207	.07279	.86880	.07393	.87548	.07507	.88211	.07623	.88868	.07739	47
14	.86218	.07281	.86892	.07395	.87559	.07509	.88222	.07625	.88879	.07741	46
15	.86229	.07283	.86903	.07397	.87570	.07511	.88233	.07627	.88890	.07743	45
+ 4′	8.86241	.07285	8.86914	.07398	8.87582	.07513	8.88244	.07628	8.88900	.07745	44
17	.86252	.07287	.86925	.07400	.87593	.07515	.88255	.07630	.88911	.07747	43
18	.86263	.07288	.86936	.07402	.87604	.07517	.88266	.07632	.88922	.07749	42
19	.86275	.07290	.86947	.07404	.87615	.07519	.88277	.07634	.88933	.07751	41
+ 5′	8.86286	.07292	8.86959	.07406	8.87626	.07521	8.88288	.07636	8.88944	.07752	40
21	.86297	.07294	.86970	.07408	.87637	.07523	.88299	.07638	.88955	.07754	39
22	.86308	.07296	.86981	.07410	.87648	.07525	.88310	.07640	.88966	.07756	38
23	.86320	.07298	.86992	.07412	.87659	.07527	.88321	.07642	.88977	.07758	37
+ 6′	8.86331	.07300	8.87003	.07414	8.87670	.07528	8.88332	.07644	8.88988	.07760	36
25	.86342	.07302	.87014	.07416	.87681	.07530	.88343	.07646	.88998	.07762	35
26	.86353	.07304	.87026	.07417	.87692	.07532	.88354	.07648	.89009	.07764	34
27	.86365	.07305	.87037	.07419	.87703	.07534	.88364	.07650	.89020	.07766	33
+ 7′	8.86376	.07307	8.87048	.07421	8.87714	.07536	8.88375	.07652	8.89031	.07768	32
29	.86387	.07309	.87059	.07423	.87725	.07538	.88386	.07654	.89042	.07770	31
30	.86398	.07311	.87070	.07425	.87737	.07540	.88397	.07656	.89053	.07772	30
31	.86410	.07323	.87081	.07427	.87748	.07542	.88408	.07657	.89064	.07774	29
+ 8′	8.86421	.07315	8.87093	.07429	8.87759	.07544	8.88419	.07659	8.89075	.07776	28
33	.86432	.07317	.87104	.07431	.87770	.07546	.88430	.07661	.89086	.07778	27
34	.86443	.07319	.87115	.07433	.87781	.07548	.88441	.07663	.89096	.07780	26
35	.86455	.07321	.87126	.07435	.87792	.07549	.88452	.07665	.89107	.07782	25
+ 9′	8.86466	.07322	8.87137	.07437	8.87803	.07551	8.88463	.07667	8.89118	.07784	24
37	.86477	.07324	.87148	.07438	.87814	.07553	.88474	.07669	.89129	.07786	23
38	.86488	.07326	.87159	.07440	.87825	.07555	.88485	.07671	.89140	.07788	22
39	.86499	.07328	.87171	.07442	.87836	.07557	.88496	.07673	.89151	.07789	21
+ 10′	8.86511	.07330	8.87182	.07444	8.87847	.07559	8.88507	.07675	8.89162	.07791	20
41	.86522	.07332	.87193	.07446	.87858	.07561	.88518	.07677	.89172	.07793	19
42	.86533	.07334	.87204	.07448	.87869	.07563	.88529	.07679	.89183	.07795	18
43	.86544	.07336	.87215	.07450	.87880	.07565	.88540	.07681	.89194	.07797	17
+ 11′	8.86556	.07338	8.87226	.07452	8.87891	.07567	8.88551	.07683	8.89205	.07799	16
45	.86567	.07340	.87237	.07454	.87902	.07569	.88562	.07685	.89216	.07801	15
46	.86578	.07341	.87248	.07456	.87913	.07571	.88573	.07686	.89227	.07803	14
47	.86589	.07343	.87260	.07458	.87924	.07573	.88584	.07688	.89238	.07805	13
+ 12′	8.86600	.07345	8.87271	.07459	8.87935	.07574	8.88595	.07690	8.89248	.07807	12
49	.86611	.07347	.87282	.07461	.87946	.07576	.88606	.07692	.89259	.07809	11
50	.86623	.07349	.87293	.07463	.87957	.07578	.88616	.07694	.89270	.07811	10
51	.86634	.07351	.87304	.07465	.87968	.07580	.88627	.07696	.89281	.07813	9
+ 13′	8.86645	.07353	8.87315	.07467	8.87980	.07582	8.88638	.07698	8.89292	.07815	8
53	.86657	.07355	.87326	.07469	.87991	.07584	.88649	.07700	.89303	.07817	7
54	.86668	.07357	.87337	.07471	.88002	.07586	.88660	.07702	.89314	.07819	6
55	.86679	.07359	.87349	.07473	.88013	.07588	.88671	.07704	.89324	.07821	5
+ 14′	8.86690	.07360	8.87360	.07475	8.88024	.07590	8.88682	.07706	8.89335	.07823	4
57	.86701	.07362	.87371	.07477	.88035	.07592	.88693	.07708	.89346	.07825	3
58	.86713	.07364	.87382	.07479	.88046	.07594	.88704	.07710	.89357	.07827	2
59	.86724	.07366	.87393	.07480	.88057	.07596	.88715	.07712	.89368	.07829	1
+ 15′	8.86735	.07368	8.87404	.07482	8.88068	.07598	8.88726	.07714	8.89379	.07830	0
	$21^h\,54^m$		$21^h\,53^m$		$21^h\,52^m$		$21^h\,51^m$		$21^h\,50^m$		

TABLE 45.

Haversines.

	2h 10m 32° 30′		2h 11m 32° 45′		2h 12m 33° 0′		2h 13m 3
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.
0	8.89379	.07830	8.90026	.07948	8.90668	.08066	8.91306
1	.89389	.07832	.90037	.07950	.90679	.08068	.91316
2	.89400	.07834	.90048	.07952	.90690	.08070	.91327
3	.89411	.07836	.90058	.07954	.90700	.08072	.91337
+ 1′	8.89422	.07838	8.90069	.07956	8.90711	.08074	8.91348
5	.89433	.07840	.90080	.07958	.90722	.08076	.91358
6	.89444	.07842	.90091	.07960	.90732	.08078	.91369
7	.89454	.07844	.90101	.07962	.90743	.08080	.91380
+ 2′	8.89465	.07846	8.90112	.07964	8.90754	.08082	8.91390
9	.89476	.07848	.90123	.07966	.90764	.08084	.91401
10	.89487	.07850	.90134	.07968	.90775	.08086	.91411
11	.89498	.07852	.90144	.07970	.90786	.08088	.91422
+ 3′	8.89509	.07854	8.90155	.07972	8.90796	.08090	8.91432
13	.89519	.07856	.90166	.07974	.90807	.08092	.91443
14	.89530	.07858	.90176	.07976	.90818	.08094	.91454
15	.89541	.07860	.90187	.07978	.90828	.08096	.91464
+ 4′	8.89552	.07862	8.90198	.07980	8.90839	.08098	8.91475
17	.89563	.07864	.90209	.07982	.90849	.08100	.91485
18	.89573	.07866	.90219	.07983	.90860	.08102	.91496
19	.89584	.07868	.90230	.07985	.90871	.08104	.91506
+ 5′	8.89595	.07870	8.90241	.07987	8.90881	.08106	8.91517
21	.89606	.07872	.90252	.07989	.90892	.08108	.91527
22	.89617	.07873	.90262	.07991	.90903	.08110	.91538
23	.89627	.07875	.90273	.07993	.90913	.08112	.91549
+ 6′	8.89638	.07877	8.90284	.07995	8.90924	.08114	8.91559
25	.89649	.07879	.90294	.07997	.90935	.08116	.91570
26	.89660	.07881	.90305	.07999	.90945	.08118	.91580
27	.89671	.07883	.90316	.08001	.90956	.08120	.91591
+ 7′	8.89681	.07885	8.90326	.08003	8.90966	.08122	8.91601
29	.89692	.07887	.90337	.08005	.90977	.08124	.91612
30	.89703	.07889	.90348	.08007	.90988	.08126	.91622
31	.89714	.07891	.90359	.08009	.90998	.08128	.91633
+ 8′	8.89725	.07893	8.90369	.08011	8.91009	.08130	8.91643
33	.89735	.07895	.90380	.08013	.91019	.08132	.91654
34	.89746	.07897	.90391	.08015	.91030	.08134	.91664
35	.89757	.07899	.90401	.08017	.91041	.08136	.91675
+ 9′	8.89768	.07901	8.90412	.08019	8.91051	.08138	8.91685
37	.89779	.07903	.90423	.08021	.91062	.08140	.91696
38	.89789	.07905	.90433	.08023	.91073	.08142	.91707
39	.89800	.07907	.90444	.08025	.91083	.08144	.91717
+ 10′	8.89811	.07909	8.90455	.08027	8.91094	.08146	8.91728
41	.89822	.07911	.90466	.08029	.91104	.08148	.91738
42	.89832	.07913	.90476	.08031	.91115	.08150	.91749
43	.89843	.07915	.90487	.08033	.91126	.08152	.91759
+ 11′	8.89854	.07917	8.90498	.08035	8.91136	.08154	8.91770
45	.89865	.07919	.90508	.08037	.91147	.08156	.91780
46	.89875	.07921	.90519	.08039	.91157	.08158	.91791
47	.89886	.07923	.90530	.08041	.91168	.08160	.91801
+ 12′	8.89897	.07924	8.90540	.08043	8.91179	.08162	8.91812
49	.89908	.07926	.90551	.08045	.91189	.08164	.91822
50	.89919	.07928	.90562	.08047	.91200	.08166	.91833
51	.89929	.07930	.90572	.08049	.91210	.08168	.91843
+ 13′	8.89940	.07932	8.90583	.08051	8.91221	.08170	8.91854
53	.89951	.07934	.90594	.08053	.91232	.08172	.91864
54	.89962	.07936	.90604	.08055	.91242	.08174	.91875
55	.89972	.07938	.90615	.08057	.91253	.08176	.91885
+ 14′	8.89983	.07940	8.90626	.08059	8.91263	.08178	8.91896
57	.89994	.07942	.90636	.08061	.91274	.08180	.91906
58	.90005	.07944	.90647	.08063	.91284	.08182	.91917
59	.90015	.07946	.90658	.08065	.91295	.08184	.91927
+ 15′	8.90026	.07948	8.90668	.08066	8.91306	.08186	8.91938
	21h 49m		21h 48m		21h 47m		21h 4

TABLE 45.

Haversines.

s	$2^h\ 15^m$ 33° 45′		$2^h\ 16^m$ 34° 0′		$2^h\ 17^m$ 34° 15′		$2^h\ 18^m$ 34° 30′		$2^h\ 19^m$ 34° 45′		
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	s
0	8.92565	.08427	8.93187	.08548	8.93805	.08671	8.94417	.08794	8.95025	.08918	60
1	.92575	.08429	.93197	.08550	.93815	.08673	.94427	.08796	.95035	.08920	59
2	.92586	.08431	.93208	.08552	.93825	.08675	.94438	.08798	.95045	.08922	58
3	.92596	.08433	.93218	.08554	.93835	.08677	.94448	.08800	.95055	.08924	57
+ 1′	8.92607	.08435	8.93228	.08556	8.93846	.08679	8.94458	.08802	8.95065	.08926	56
5	.92617	.08437	.93239	.08558	.93856	.08681	.94468	.08804	.95076	.08928	55
6	.92627	.08439	.93249	.08560	.93866	.08683	.94478	.08806	.95086	.08930	54
7	.92638	.08441	.93259	.08562	.93876	.08685	.94488	.08808	.95096	.08932	53
+ 2′	8.92648	.08443	8.93270	.08564	8.93886	.08687	8.94498	.08810	8.95106	.08934	52
9	.92659	.08445	.93280	.08566	.93897	.08689	.94509	.08812	.95116	.08936	51
10	.92669	.08447	.93290	.08568	.93907	.08691	.94519	.08814	.95126	.08938	50
11	.92679	.08449	.93301	.08571	.93917	.08693	.94529	.08816	.95136	.08940	49
+ 3′	8.92690	.08451	8.93311	.08573	8.93927	.08695	8.94539	.08818	8.95146	.08943	48
13	.92700	.08453	.93321	.08575	.93938	.08697	.94549	.08820	.95156	.08945	47
14	.92710	.08455	.93332	.08577	.93948	.08699	.94559	.08823	.95166	.08947	46
15	.92721	.08457	.93342	.08579	.93958	.08701	.94570	.08825	.95176	.08949	45
+ 4′	8.92731	.08459	8.93352	.08581	8.93968	.08703	8.94580	.08827	8.95186	.08951	44
17	.92742	.08461	.93363	.08583	.93979	.08705	.94590	.08829	.95197	.08953	43
18	.92752	.08463	.93373	.08585	.93989	.08707	.94600	.08831	.95207	.08955	42
19	.92762	.08465	.93383	.08587	.93999	.08709	.94610	.08833	.95217	.08957	41
+ 5′	8.92773	.08467	8.93393	.08589	8.94009	.08711	8.94620	.08835	8.95227	.08959	40
21	.92783	.08469	.93404	.08591	.94019	.08714	.94630	.08837	.95237	.08961	39
22	.92794	.08471	.93414	.08593	.94030	.08716	.94641	.08839	.95247	.08963	38
23	.92804	.08473	.93424	.08595	.94040	.08718	.94651	.08841	.95257	.08965	37
+ 6′	8.92814	.08475	8.93435	.08597	8.94050	.08720	8.94661	.08843	8.95267	.08967	36
25	.92825	.08477	.93445	.08599	.94060	.08722	.94671	.08845	.95277	.08970	35
26	.92835	.08479	.93455	.08601	.94071	.08724	.94681	.08847	.95287	.08972	34
27	.92845	.08481	.93466	.08603	.94081	.08726	.94691	.08849	.95297	.08974	33
+ 7′	8.92856	.08483	8.93476	.08605	8.94091	.08728	8.94701	.08851	8.95307	.08976	32
29	.92866	.08485	.93486	.08607	.94101	.08730	.94712	.08853	.95317	.08978	31
30	.92877	.08487	.93496	.08609	.94111	.08732	.94722	.08856	.95327	.08980	30
31	.92887	.08489	.93507	.08611	.94122	.08734	.94732	.08858	.95337	.08982	29
+ 8′	8.92897	.08491	8.93517	.08613	8.94132	.08736	8.94742	.08860	8.95347	.08984	28
33	.92908	.08493	.93527	.08615	.94142	.08738	.94752	.08862	.95357	.08986	27
34	.92918	.08495	.93538	.08617	.94152	.08740	.94762	.08864	.95368	.08988	26
35	.92928	.08497	.93548	.08619	.94162	.08742	.94772	.08866	.95378	.08990	25
+ 9′	8.92939	.08499	8.93558	.08621	8.94173	.08744	8.94782	.08868	8.95388	.08992	24
37	.92949	.08501	.93568	.08624	.94183	.08746	.94793	.08870	.95398	.08994	23
38	.92960	.08503	.93579	.08626	.94193	.08748	.94803	.08872	.95408	.08997	22
39	.92970	.08505	.93589	.08628	.94203	.08750	.94813	.08874	.95418	.08999	21
+ 10′	8.92980	.08508	8.93599	.08630	8.94213	.08753	8.94823	.08876	8.95428	.09001	20
41	.92991	.08510	.93610	.08632	.94224	.08755	.94833	.08878	.95438	.09003	19
42	.93001	.08512	.93620	.08634	.94234	.08757	.94843	.08880	.95448	.09005	18
43	.93011	.08514	.93630	.08636	.94244	.08759	.94853	.08882	.95458	.09007	17
+ 11′	8.93022	.08516	8.93640	.08638	8.94254	.08761	8.94863	.08885	8.95468	.09009	16
45	.93032	.08518	.93651	.08640	.94264	.08763	.94874	.08887	.95478	.09011	15
46	.93042	.08520	.93661	.08642	.94275	.08765	.94884	.08889	.95488	.09013	14
47	.93053	.08522	.93671	.08644	.94285	.08767	.94894	.08891	.95498	.09015	13
+ 12′	8.93063	.08524	8.93681	.08646	8.94295	.08769	8.94904	.08893	8.95508	.09017	12
49	.93073	.08526	.93692	.08648	.94305	.08771	.94914	.08895	.95518	.09019	11
50	.93084	.08528	.93702	.08650	.94315	.08773	.94924	.08897	.95528	.09022	10
51	.93094	.08530	.93712	.08652	.94326	.08775	.94934	.08899	.95538	.09024	9
+ 13′	8.93104	.08532	8.93722	.08654	8.94336	.08777	8.94944	.08901	8.95548	.09026	8
53	.93115	.08534	.93733	.08656	.94346	.08779	.94954	.08903	.95558	.09028	7
54	.93125	.08536	.93743	.08658	.94356	.08781	.94965	.08905	.95568	.09030	6
55	.93135	.08538	.93753	.08660	.94366	.08783	.94975	.08907	.95578	.09032	5
+ 14′	8.93146	.08540	8.93764	.08662	8.94376	.08785	8.94985	.08909	8.95588	.09034	4
57	.93156	.08542	.93774	.08664	.94387	.08788	.94995	.08911	.95598	.09036	3
58	.93166	.08544	.93784	.08666	.94397	.08790	.95005	.08914	.95608	.09038	2
59	.93177	.08546	.93794	.08668	.94407	.08792	.95015	.08916	.95618	.09040	1
+ 15′	8.93187	.08548	8.93805	.08671	8.94417	.08794	8.95025	.08918	8.95628	.09042	0
	$21^h\ 44^m$		$21^h\ 43^m$		$21^h\ 42^m$		$21^h\ 41^m$		$21^h\ 40^m$		

TABLE 45.

Haversines.

	$2^h\ 20^m$ 35° 0′		$2^h\ 21^m$ 35° 15′		$2^h\ 22^m$ 35° 30′		$2^h\ 23^m$ 3
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.
0	8.95628	.09042	8.96227	.09168	8.96821	.09294	8.97411
1	.95638	.09044	.96237	.09170	.96831	.09296	.97421
2	.95648	.09047	.96247	.09172	.96841	.09298	.97431
3	.95658	.09049	.96257	.09174	.96851	.09301	.97441
+ 1′	8.95668	.09051	8.96267	.09176	8.96861	.09303	8.97450
5	.95678	.09053	.96277	.09178	.96871	.09305	.97460
6	.95688	.09055	.96287	.09181	.96881	.09307	.97470
7	.95698	.09057	.96297	.09183	.96890	.09309	.97480
+ 2′	8.95709	.09059	8.96307	.09185	8.96900	.09311	8.97489
9	.95719	.09061	.96317	.09187	.96910	.09313	.97499
10	.95729	.09063	.96326	.09189	.96920	.09315	.97509
11	.95739	.09065	.96336	.09191	.96930	.09317	.97519
+ 3′	8.95749	.09067	8.96346	.09193	8.96940	.09320	8.97529
13	.95759	.09070	.96356	.09195	.96950	.09322	.97538
14	.95769	.09072	.96366	.09197	.96959	.09324	.97548
15	.95779	.09074	.96376	.09199	.96969	.09326	.97558
+ 4′	8.95789	.09076	8.96386	.09202	8.96979	.09328	8.97568
17	.95799	.09078	.96396	.09204	.96989	.09330	.97577
18	.95809	.09080	.96406	.09206	.96999	.09332	.97587
19	.95819	.09082	.96416	.09208	.97009	.09334	.97597
+ 5′	8.95828	.09084	8.96426	.09210	8.97018	.09337	8.97607
21	.95838	.09086	.96436	.09212	.97028	.09339	.97617
22	.95848	.09088	.96446	.09214	.97038	.09341	.97626
23	.95858	.09090	.96455	.09216	.97048	.09343	.97636
+ 6′	8.95868	.09093	8.96465	.09218	8.97058	.09345	8.97646
25	.95878	.09095	.96475	.09220	.97068	.09347	.97656
26	.95888	.09097	.96485	.09223	.97077	.09349	.97665
27	.95898	.09099	.96495	.09225	.97087	.09351	.97675
+ 7′	8.95908	.09101	8.96505	.09227	8.97097	.09353	8.97685
29	.95918	.09103	.96515	.09229	.97107	.09355	.97695
30	.95928	.09105	.96525	.09231	.97117	.09358	.97704
31	.95938	.09107	.96535	.09233	.97127	.09360	.97714
+ 8′	8.95948	.09109	8.96545	.09235	8.97136	.09362	8.97724
33	.95958	.09111	.96555	.09237	.97146	.09364	.97734
34	.95968	.09113	.96564	.09239	.97156	.09366	.97743
35	.95978	.09116	.96574	.09242	.97166	.09368	.97753
+ 9′	8.95988	.09118	8.96584	.09244	8.97176	.09370	8.97763
37	.95998	.09120	.96594	.09246	.97186	.09372	.97773
38	.96008	.09122	.96604	.09248	.97195	.09375	.97782
39	.96018	.09124	.96614	.09250	.97205	.09377	.97792
+ 10′	8.96028	.09126	8.96624	.09252	8.97215	.09379	8.97802
41	.96038	.09128	.96634	.09254	.97225	.09381	.97812
42	.96048	.09130	.96644	.09256	.97235	.09383	.97821
43	.96058	.09132	.96653	.09258	.97244	.09385	.97831
+ 11′	8.96068	.09134	8.96663	.09260	8.97254	.09387	8.97841
45	.96078	.09136	.96673	.09263	.97264	.09389	.97851
46	.96088	.09139	.96683	.09265	.97274	.09392	.97860
47	.96098	.09141	.96693	.09267	.97284	.09394	.97870
+ 12′	8.96108	.09143	8.96703	.09269	8.97294	.09396	8.97880
49	.96118	.09145	.96713	.09271	.97303	.09398	.97890
50	.96128	.09147	.96723	.09273	.97313	.09400	.97899
51	.96138	.09149	.96733	.09275	.97323	.09402	.97909
+ 13′	8.96148	.09151	8.96742	.09277	8.97333	.09404	8.97919
53	.96158	.09153	.96752	.09280	.97343	.09406	.97928
54	.96167	.09155	.96762	.09282	.97352	.09408	.97938
55	.96177	.09157	.96772	.09284	.97362	.09411	.97948
+ 14′	8.96187	.09160	8.96782	.09286	8.97372	.09413	8.97958
57	.96197	.09162	.96792	.09288	.97382	.09415	.97967
58	.96207	.09164	.96802	.09290	.97392	.09417	.97977
59	.96217	.09166	.96812	.09292	.97401	.09419	.97987
+ 15′	8.96227	.09168	8.96821	.09294	8.97411	.09421	8.97997
	$21^h\ 39^m$		$21^h\ 38^m$		$21^h\ 37^m$		21^h

TABLE 45.

Haversines.

s	2h 25m 36° 15'		2h 26m 36° 30'		2h 27m 36° 45'		2h 28m 37° 0'		2h 29m 37° 15'		s
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	s
0	8.98578	.09678	8.99154	.09807	8.99727	.09937	9.00295	.10068	9.00860	.10200	60
1	.98587	.09680	.99164	.09809	.99736	.09939	.00305	.10070	.00869	.10202	59
2	.98597	.09682	.99173	.09811	.99746	.09942	.00314	.10073	.00878	.10204	58
3	.98606	.09684	.99183	.09814	.99755	.09944	.00324	.10075	.00888	.10206	57
+ 1'	8.98616	.09686	8.99193	.09816	8.99765	.09946	9.00333	.10077	9.00897	.10209	56
5	.98626	.09689	.99202	.09818	.99774	.09948	.00342	.10079	.00906	.10211	55
6	.98635	.09691	.99212	.09820	.99784	.09950	.00352	.10081	.00916	.10213	54
7	.98645	.09693	.99221	.09822	.99793	.09953	.00361	.10084	.00925	.10215	53
+ 2'	8.98655	.09695	8.99231	.09824	8.99803	.09955	9.00371	.10086	9.00935	.10218	52
9	.98664	.09697	.99240	.09827	.99812	.09957	.00380	.10088	.00944	.10220	51
10	.98674	.09699	.99250	.09829	.99822	.09959	.00390	.10090	.00953	.10222	50
11	.98684	.09701	.99260	.09831	.99831	.09961	.00399	.10092	.00963	.10224	49
+ 3'	8.98693	.09704	8.99269	.09833	8.99841	.09963	9.00408	.10095	9.00972	.10226	48
13	.98703	.09706	.99279	.09835	.99850	.09966	.00418	.10097	.00981	.10228	47
14	.98712	.09708	.99288	.09837	.99860	.09968	.00427	.10099	.00991	.10231	46
15	.98722	.09710	.99298	.09840	.99869	.09970	.00437	.10101	.01000	.10233	45
+ 4'	8.98732	.09712	8.99307	.09842	8.99879	.09972	9.00446	.10103	9.01009	.10235	44
17	.98741	.09714	.99317	.09844	.99888	.09974	.00456	.10105	.01019	.10237	43
18	.98751	.09717	.99327	.09846	.99898	.09977	.00465	.10108	.01028	.10240	42
19	.98761	.09719	.99336	.09848	.99907	.09979	.00474	.10110	.01037	.10242	41
+ 5'	8.98770	.09721	8.99346	.09850	8.99917	.09981	9.00484	.10112	9.01047	.10244	40
21	.98780	.09723	.99355	.09853	.99926	.09983	.00493	.10114	.01056	.10246	39
22	.98790	.09725	.99365	.09855	.99936	.09985	.00503	.10116	.01065	.10248	38
23	.98799	.09727	.99374	.09857	.99945	.09987	.00512	.10119	.01075	.10251	37
+ 6'	8.98809	.09729	8.99384	.09859	8.99955	.09989	9.00522	.10121	9.01084	.10253	36
25	.98818	.09732	.99393	.09861	.99964	.09992	.00531	.10123	.01094	.10255	35
26	.98828	.09734	.99403	.09863	.99974	.09994	.00540	.10125	.01103	.10257	34
27	.98838	.09736	.99412	.09866	.99983	.09996	.00550	.10127	01112	.10259	33
+ 7'	8.98847	.09738	8.99422	.09868	8.99993	.09998	9.00559	.10130	9.01122	.10262	32
29	.98857	.09740	.99432	.09870	9.00002	.10000	.00569	.10132	.01131	.10264	31
30	.98866	.09742	.99441	.09872	.00012	.10003	.00578	.10134	.01140	.10266	30
31	.98876	.09745	.99451	.09874	.00021	.10005	.00587	.10136	.01150	.10268	29
+ 8'	8.98886	.09747	8.99460	.09876	9.00031	.10007	9.00597	.10138	9.01159	.10270	28
33	.98895	.09749	.99470	.09879	.00040	.10009	.00606	.10141	.01168	.10273	27
34	.98905	.09751	.99479	.09881	.00049	.10011	.00616	.10143	.01178	.10275	26
35	.98915	.09753	.99489	.09883	.00059	.10014	.00625	.10145	.01187	.10277	25
+ 9'	8.98924	.09755	8.99498	.09885	9.00068	.10016	9.00634	.10147	9.01196	.10279	24
37	.98934	.09757	.99508	.09887	.00078	.10018	.00644	.10149	.01206	.10281	23
38	.98943	.09760	.99517	.09890	.00087	.10020	.00653	.10152	.01215	.10284	22
39	.98953	.09762	.99527	.09892	.00097	.10022	.00663	.10154	.01224	.10286	21
+ 10'	8.98963	.09764	8.99536	.09894	9.00106	.10025	9.00672	.10156	9.01234	.10288	20
41	.98972	.09766	.99546	.09896	.00116	.10027	.00681	.10158	.01243	.10290	19
42	.98982	.09768	.99556	.09898	.00125	.10029	.00691	.10160	.01252	.10293	18
43	.98991	.09770	.99565	.09900	.00135	.10031	.00700	.10163	.01262	.10295	17
+ 11'	8.99001	.09773	8.99575	.09902	9.00144	.10033	9.00710	.10165	9.01271	.10297	16
45	.99011	.09775	.99584	.09905	.00154	.10035	.00719	.10167	.01280	.10299	15
46	.99020	.09777	.99594	.09907	.00163	.10038	.00728	.10169	.01289	.10301	14
47	.99030	.09779	.99603	.09909	.00172	.10040	.00738	.10171	.01299	.10304	13
+ 12'	8.99039	.09781	8.99613	.09911	9.00182	.10042	9.00747	.10174	9.01308	.10306	12
49	.99049	.09783	.99622	.09913	.00191	.10044	.00756	.10176	.01317	.10308	11
50	.99058	.09786	.99632	.09916	.00201	.10046	.00766	.10178	.01327	.10310	10
51	.99068	.09788	.99641	.09918	.00210	.10049	.00775	.10180	.01336	.10312	9
+ 13'	8.99078	.09790	8.99651	.09920	9.00220	.10051	9.00785	.10182	9.01345	.10315	8
53	.99087	.09792	.99660	.09922	.00229	.10053	.00794	.10184	.01355	.10317	7
54	.99097	.09794	.99670	.09924	.00239	.10055	.00803	.10187	.01364	.10319	6
55	.99106	.09796	.99679	.09926	.00248	.10057	.00813	.10189	.01373	.10321	5
+ 14'	8.99116	.09799	8.99689	.09929	9.00258	.10059	9.00822	.10191	9.01383	.10324	4
57	.99126	.09801	.99698	.09931	.00267	.10062	.00831	.10193	.01392	.10326	3
58	.99135	.09803	.99708	.09933	.00276	.10064	.00841	.10196	.01401	.10328	2
59	.99145	.09805	.99717	.09935	.00286	.10066	.00850	.10198	.01411	.10331	1
+ 15'	8.99154	.09807	8.99727	.09937	9.00295	.10068	9.00860	.10200	9.01420	.10333	0
	21h 34m		21h 33m		21h 32m		21h 31m		21h 30m		

TABLE 45.

Haversines.

	$2^{h}\ 30^{m}$ 37° 30′		$2^{h}\ 31^{m}$ 37° 45′		$2^{h}\ 32^{m}$ 38° 0′		$2^{h}\ 33^{m}$
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.
0	9.01420	.10332	9.01976	.10466	9.02528	.10599	9.03077
1	.01429	.10335	.01985	.10468	.02538	.10602	.03086
2	.01438	.10337	.01995	.10470	.02547	.10604	.03095
3	.01448	.10339	.02004	.10472	.02556	.10606	.03104
+ 1′	9.01457	.10341	9.02013	.10474	9.02565	.10608	9.03113
5	.01466	.10343	.02022	.10477	.02574	.10611	.03122
6	.01476	.10346	.02031	.10479	.02583	.10613	.03131
7	.01485	.10348	.02041	.10481	.02593	.10615	.03141
+ 2′	9.01494	.10350	9.02050	.10483	9.02602	.10617	9.03150
9	.01504	.10352	.02059	.10486	.02611	.10620	.03159
10	.01513	.10354	.02068	.10488	.02620	.10622	.03168
11	.01522	.10357	.02078	.10490	.02629	.10624	.03177
+ 3′	9.01531	.10359	9.02087	.10492	9.02638	.10626	9.03186
13	.01541	.10361	.02096	.10494	.02648	.10629	.03195
14	.01550	.10363	.02105	.10497	.02657	.10631	.03204
15	.01559	.10366	.02115	.10499	.02666	.10633	.03213
+ 4′	9.01569	.10368	9.02124	.10501	9.02675	.10635	9.03222
17	.01578	.10370	.02133	.10503	.02684	.10638	.03231
18	.01587	.10372	.02142	.10506	.02693	.10640	.03241
19	.01596	.10374	.02151	.10508	.02702	.10642	.03250
+ 5′	9.01606	.10377	9.02161	.10510	9.02712	.10644	9.03259
21	.01615	.10379	.02170	.10512	.02721	.10647	.03268
22	.01624	.10381	.02179	.10515	.02730	.10649	.03277
23	.01634	.10383	.02188	.10517	.02739	.10651	.03286
+ 6′	9.01643	.10386	9.02197	.10519	9.02748	.10653	9.03295
25	.01652	.10388	.02207	.10521	.02757	.10655	.03304
26	.01661	.10390	.02216	.10523	.02767	.10658	.03313
27	.01671	.10392	.02225	.10526	.02776	.10660	.03322
+ 7′	9.01680	.10394	9.02234	.10528	9.02785	.10662	9.03331
29	.01689	.10397	.02244	.10530	.02794	.10664	.03340
30	.01698	.10399	.02253	.10532	.02803	.10667	.03350
31	.01708	.10401	.02262	.10535	.02812	.10669	.03359
+ 8′	9.01717	.10403	9.02271	.10537	9.02821	.10671	9.03368
33	.01726	.10405	.02280	.10539	.02830	.10673	.03377
34	.01736	.10408	.02290	.10541	.02840	.10676	.03386
35	.01745	.10410	.02299	.10544	.02849	.10678	.03395
+ 9′	9.01754	.10412	9.02308	.10546	9.02858	.10680	9.03404
37	.01763	.10414	.02317	.10548	.02867	.10682	.03413
38	.01773	.10417	.02326	.10550	.02876	.10685	.03422
39	.01782	.10419	.02336	.10552	.02885	.10687	.03431
+ 10′	9.01791	.10421	9.02345	.10555	9.02894	.10689	9.03440
41	.01800	.10423	.02354	.10557	.02904	.10691	.03449
42	.01810	.10425	.02363	.10559	.02913	.10694	.03458
43	.01819	.10428	.02372	.10561	.02922	.10696	.03467
+ 11′	9.01828	.10430	9.02381	.10564	9.02931	.10698	9.03476
45	.01837	.10432	.02391	.10566	.02940	.10700	03486
46	.01847	.10434	.02400	.10568	.02949	.10703	.03495
47	.01856	.10436	.02409	.10570	.02958	.10705	.03504
+ 12′	9.01865	.10439	9.02418	.10573	9.02967	.10707	9.03513
49	.01874	.10441	.02427	.10575	.02977	.10709	.03522
50	.01884	.10443	.02437	.10577	.02986	.10712	.03531
51	.01893	.10445	.02446	.10579	.02995	.10714	.03540
+ 13′	9.01902	.10448	9.02455	.10582	9.03004	.10716	9.03549
53	.01911	.10450	.02464	.10584	.03013	.10718	.03558
54	.01921	.10452	.02473	.10586	.03022	.10721	.03567
55	.01930	.10454	.02483	.10588	.03031	.10723	.03576
+ 14′	9.01939	.10457	9.02492	.10591	9.03040	.10725	9.03585
57	01948	.10459	.02501	.10593	.03050	.10727	.03594
58	.01958	.10461	.02510	.10595	.03059	.10730	.03603
59	.01967	.10463	.02519	.10597	.03068	.10732	.03612
+ 15′	9.01976	.10466	9.02528	.10599	9.03077	.10734	9.03621
	$21^{h}\ 29^{m}$		$21^{h}\ 28^{m}$		$21^{h}\ 27^{m}$		21^{h}

TABLE 45.

Haversines.

s	$2^{h}\ 35^{m}$ 38° 45′		$2^{h}\ 36^{m}$ 39° 0′		$2^{h}\ 37^{m}$ 39° 15′		$2^{h}\ 38^{m}$ 39° 30′		$2^{h}\ 39^{m}$ 39° 45′		s
	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	
0	9.04162	.11006	9.04699	.11143	9.05232	.11280	9.05762	.11419	9.06288	.11558	60
1	.04171	.11008	.04708	.11145	.05241	.11283	.05771	.11421	.06297	.11560	59
2	.04180	.11010	.04717	.11147	.05250	.11285	.05780	.11423	.06305	.11563	58
3	.04189	.11013	.04726	.11150	.05259	.11287	.05788	.11426	.06314	.11565	57
+ 1′	9.04198	.11015	9.04735	.11152	9.05268	.11290	9.05797	.11428	9.06323	.11567	56
5	.04207	.11017	.04744	.11154	.05277	.11292	.05806	.11430	.06332	.11569	55
6	.04216	.11019	.04753	.11156	.05285	.11294	.05815	.11433	.06340	.11572	54
7	.04225	.11022	.04761	.11159	.05294	.11296	.05823	.11435	.06349	.11574	53
+ 2′	9.04234	.11024	9.04770	.11161	9.05303	.11299	9.05832	.11437	9.06358	.11577	52
9	.04243	.11026	.04779	.11163	.05312	.11301	.05841	.11440	.06367	.11579	51
10	.04252	.11029	.04788	.11166	.05321	.11303	.05850	.11442	.06375	.11581	50
11	.04261	.11031	.04797	.11168	.05330	.11306	.05859	.11444	.06384	.11584	49
+ 3′	9.04270	.11033	9.04806	.11170	9.05339	.11308	9.05867	.11447	9.06393	.11586	48
13	.04279	.11035	.04815	.11172	.05347	.11310	.05876	.11449	.06401	.11588	47
14	.04288	.11038	.04824	.11175	.05356	.11313	.05885	.11451	.06410	.11590	46
15	.04297	.11040	.04833	.11177	.05365	.11315	.05894	.11453	.06419	.11593	45
+ 4′	9.04306	.11042	9.04842	.11179	9.05374	.11317	9.05903	.11456	9.06428	.11595	44
17	.04315	.11044	.04851	.11182	.05383	.11320	.05911	.11458	.06436	.11597	43
18	.04324	.11047	.04859	.11184	.05392	.11322	.05920	.11460	.06445	.11600	42
19	.04333	.11049	.04868	11186	.05400	.11324	.05929	.11463	.06454	.11602	41
+ 5′	9.04341	.11051	9.04877	.11189	9.05409	.11326	9.05938	.11465	9.06462	.11604	40
21	.04350	.11054	.04886	.11191	.05418	.11329	.05946	.11467	.06471	.11607	39
22	.04359	.11056	.04895	.11193	.05427	.11331	.05955	.11470	.06480	.11609	38
23	.04368	.11058	.04904	.11195	.05436	.11333	.05964	.11472	.06489	.11611	37
+ 6′	9.04377	.11060	9.04913	.11198	9.05445	.11336	9.05973	.11474	9.06497	.11614	36
25	.04386	.11063	.04922	.11200	.05453	.11338	.05982	.11477	.06506	.11616	35
26	.04395	.11065	.04931	.11202	.05462	.11340	.05990	.11479	.06515	.11618	34
27	.04404	.11067	.04939	.11205	.05471	.11343	.05999	.11481	.06523	.11621	33
+ 7′	9.04413	.11070	9.04948	.11207	9.05480	.11345	9.06008	.11484	9.06532	.11623	32
29	.04422	.11072	.04957	.11209	.05489	.11347	.06017	.11486	.06541	.11625	31
30	.04431	.11074	.04966	.11211	.05498	.11349	.06025	.11488	.06550	.11628	30
31	.04440	.11076	.04975	.11214	.05506	.11352	.06034	.11491	.06558	.11630	29
+ 8′	9.04449	.11079	9.04984	.11216	9.05515	.11354	9.06043	.11493	9.06567	.11632	28
33	.04458	.11081	.04993	.11218	.05524	.11356	.06052	.11495	.06576	.11635	27
34	.04467	.11083	.05002	.11221	.05533	.11359	.06060	.11498	.06584	.11637	26
35	.04476	.11086	.05011	.11223	.05542	.11361	.06069	.11500	.06593	.11639	25
+ 9′	9.04485	.11088	9.05019	.11225	9.05551	.11363	9.06078	.11502	9.06602	.11642	24
37	.04494	.11090	.05028	.11228	.05559	.11366	.06087	.11504	.06611	.11644	23
38	.04503	.11092	.05037	.11230	.05568	.11368	.06095	.11507	.06619	.11646	22
39	.04512	.11095	.05046	.11232	.05577	.11370	.06104	.11509	.06628	.11649	21
+ 10′	9.04520	.11097	9.05055	.11234	9.05586	.11373	9.06113	.11511	9.06637	.11651	20
41	.04529	.11099	.05064	.11237	.05595	.11375	.06122	.11514	.06645	.11653	19
42	.04538	.11102	.05073	.11239	.05603	.11377	.06131	.11516	.06654	.11656	18
43	.04547	.11104	.05082	.11241	.05612	.11379	.06139	.11518	.06663	.11658	17
+ 11′	9.04556	.11106	9.05090	.11244	9.05621	.11382	9.06148	.11521	9.06671	.11660	16
45	.04565	.11108	.05099	.11246	.05630	.11384	.06157	.11523	.06680	.11663	15
46	.04574	.11111	.05108	.11248	.05639	.11386	.06166	.11525	.06689	.11665	14
47	.04583	.11113	.05117	.11251	.05648	.11389	.06174	.11528	.06697	.11667	13
+ 12′	9.04592	.11115	9.05126	.11253	9.05656	.11391	9.06183	.11530	9.06706	.11670	12
49	.04601	.11117	.05135	.11255	.05665	.11393	.06192	.11532	.06715	.11672	11
50	.04610	.11120	.05144	.11257	.05674	.11396	.06201	.11535	.06724	.11674	10
51	.04619	.11122	.05153	.11260	.05683	.11398	.06209	.11537	.06732	.11677	9
+ 13′	9.04628	.11124	9.05161	.11262	9.05692	.11400	9.06218	.11539	9.06741	.11679	8
53	.04637	.11127	.05170	.11264	.05700	.11403	.06227	.11542	.06750	.11681	7
54	.04646	.11129	.05179	.11267	.05709	.11405	.06235	.11544	.06758	.11684	6
55	.04654	.11131	.05188	.11269	.05718	.11407	.06244	.11546	.06767	.11686	5
+ 14′	9.04663	.11134	9.05197	.11271	9.05727	.11410	9.06253	.11549	9.06776	.11688	4
57	.04672	.11136	.05206	.11274	.05736	.11412	.06262	.11551	.06784	.11691	3
58	.04681	.11138	.05215	.11276	.05744	.11414	.06270	.11553	.06793	.11693	2
59	.04690	.11140	.05223	.11278	.05753	.11416	.06279	.11556	.06802	.11695	1
+ 15′	9.04699	.11143	9.05232	.11280	9.05762	.11419	9.06288	.11558	9.06810	.11698	0
	$21^{h}\ 24^{m}$		$21^{h}\ 23^{m}$		$21^{h}\ 22^{m}$		$21^{h}\ 21^{m}$		$21^{h}\ 20^{m}$		

TABLE 45.

Haversines.

s	$2^h\,40^m$ 40° 0′		$2^h\,41^m$ 40° 15′		$2^h\,42^m$ 40° 30′		$2^h\,43^m$ 40° 45′		$2^h\,44^m$ 41° 0′		s
	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	
0	9.06810	.11698	9.07329	.11838	9.07845	.11980	9.08357	.12122	9.08865	.12265	60
1	.06819	.11700	.07338	.11841	.07853	.11982	.08365	.12124	.08874	.12267	59
2	.06828	.11702	.07346	.11843	.07862	.11984	.08374	.12127	.08882	.12269	58
3	.06836	.11705	.07355	.11845	.07870	.11987	.08382	.12129	.08890	.12272	57
+ 1′	9.06845	.11707	9.07364	.11848	9.07879	.11989	9.08391	.12131	9.08899	.12274	56
5	.06854	.11709	.07372	.11850	.07887	.11992	.08399	.12134	.08907	.12276	55
6	.06862	.11712	.07381	.11852	.07896	.11994	.08408	.12136	.08916	.12279	54
7	.06871	.11714	.07390	.11855	.07905	.11996	.08416	.12138	.08924	.12281	53
+ 2′	9.06880	.11716	9.07398	.11857	9.07913	.11999	9.08425	.12141	9.08933	.12284	52
9	.06888	.11719	.07407	.11860	.07922	.12001	.08433	.12143	.08941	.12286	51
10	.06897	.11721	.07415	.11862	.07930	.12003	.08442	.12146	.08949	.12288	50
11	.06906	.11724	.07424	.11864	.07939	.12006	.08450	.12148	.08958	.12291	49
+ 3′	9.06914	.11726	9.07433	.11867	9.07947	.12008	9.08459	.12150	9.08966	.12293	48
13	.06923	.11728	.07441	.11869	.07956	.12010	.08467	.12153	.08975	.12296	47
14	.06932	.11731	.07450	.11871	.07964	.12013	.08475	.12155	.08983	.12298	46
15	.06940	.11733	.07458	.11874	.07973	.12015	.08484	.12157	.08992	.12300	45
+ 4′	9.06949	.11735	9.07467	.11876	9.07981	.12018	9.08492	.12160	9.09000	.12303	44
17	.06958	.11738	.07476	.11878	.07990	.12020	.08501	.12162	.09009	.12305	43
18	.06966	.11740	.07484	.11881	.07999	.12022	.08509	.12165	.09017	.12307	42
19	.06975	.11742	.07493	.11883	.08007	.12025	.08518	.12167	.09025	.12310	41
+ 5′	9.06984	.11745	9.07501	.11885	9.08016	.12027	9.08526	.12169	9.09034	.12312	40
21	.06992	.11747	.07510	.11888	.08024	.12029	.08535	.12172	.09042	.12315	39
22	.07001	.11749	.07519	.11890	.08033	.12032	.08543	.12174	.09051	.12317	38
23	.07010	.11752	.07527	.11892	.08041	.12034	.08552	.12176	.09059	.12319	37
+ 6′	9.07018	.11754	9.07536	.11895	9.08050	.12036	9.08560	.12179	9.09068	.12322	36
25	.07027	.11756	.07544	.11897	.08058	.12039	.08569	.12181	.09076	.12324	35
26	.07036	.11759	.07553	.11900	.08067	.12041	.08577	.12184	.09084	.12327	34
27	.07044	.11761	.07562	.11902	.08075	.12044	.08586	.12186	.09093	.12329	33
+ 7′	9.07053	.11763	9.07570	.11904	9.08084	.12046	9.08594	.12188	9.09101	.12331	32
29	.07062	.11766	.07579	.11907	.08092	.12048	.08603	.12191	.09110	.12334	31
30	.07070	.11768	.07587	.11909	.08101	.12051	.08611	.12193	.09118	.12336	30
31	.07079	.11770	.07596	.11911	.08110	.12053	.08620	.12195	.09126	.12339	29
+ 8′	9.07088	.11773	9.07605	.11914	9.08118	.12055	9.08628	.12198	9.09135	.12341	28
33	.07096	.11775	.07613	.11916	.08127	.12058	.08637	.12200	.09143	.12343	27
34	.07105	.11777	.07622	.11918	.08135	.12060	.08645	.12203	.09152	.12346	26
35	.07113	.11780	.07630	.11921	.08144	.12062	.08654	.12205	.09160	.12348	25
+ 9′	9.07122	.11782	9.07639	.11923	9.08152	.12065	9.08662	.12207	9.09169	.12351	24
37	.07131	.11784	.07647	.11925	.08161	.12067	.08671	.12210	.09177	.12353	23
38	.07139	.11787	.07656	.11928	.08169	.12070	.08679	.12212	.09185	.12355	22
39	.07148	.11789	.07665	.11930	.08178	.12072	.08687	.12214	.09194	.12358	21
+ 10′	9.07157	.11791	9.07673	.11933	9.08186	.12074	9.08696	.12217	9.09202	.12360	20
41	.07165	.11794	.07682	.11935	.08195	.12077	.08704	.12219	.09211	.12363	19
42	.07174	.11796	.07690	.11937	.08203	.12079	.08713	.12222	.09219	.12365	18
43	.07183	.11798	.07699	.11940	.08212	.12081	.08721	.12224	.09227	.12367	17
+ 11′	9.07191	.11801	9.07708	.11942	9.08220	.12084	9.08730	.12226	9.09236	.12370	16
45	.07200	.11803	.07716	.11944	.08229	.12086	.08738	.12229	.09244	.12372	15
46	.07208	.11806	.07725	.11947	.08237	.12089	.08747	.12231	.09253	.12374	14
47	.07217	.11808	.07733	.11949	.08246	.12091	.08755	.12233	.09261	.12377	13
+ 12′	9.07226	.11810	9.07742	.11951	9.08254	.12093	9.08764	.12236	9.09269	.12379	12
49	.07234	.11813	.07750	.11954	.08263	.12096	.08772	.12238	.09278	.12382	11
50	.07243	.11815	.07759	.11956	.08271	.12098	.08781	.12241	.09286	.12384	10
51	.07252	.11817	.07768	.11958	.08280	.12100	.08789	.12243	.09295	.12386	9
+ 13′	9.07260	.11820	9.07776	.11961	9.08288	.12103	9.08797	.12245	9.09303	.12389	8
53	.07269	.11822	.07785	.11963	.08297	.12105	.08806	.12248	.09311	.12391	7
54	.07277	.11824	.07793	.11966	.08306	.12108	.08814	.12250	.09320	.12394	6
55	.07286	.11827	.07802	.11968	.08314	.12110	.08823	.12253	.09328	.12396	5
+ 14′	9.07295	.11829	9.07810	.11970	9.08323	.12112	9.08831	.12255	9.09337	.12398	4
57	.07303	.11831	.07819	.11973	.08331	.12115	.08840	.12257	.09345	.12401	3
58	.07312	.11834	.07827	.11975	.08340	.12117	.08848	.12260	.09353	.12403	2
59	.07321	.11836	.07836	.11977	.08348	.12119	.08857	.12262	.09362	.12406	1
+ 15′	9.07329	.11838	9.07845	.11980	9.08357	.12122	9.08865	.12265	9.09370	.12408	0
	$21^h\,19^m$		$21^h\,18^m$		$21^h\,17^m$		$21^h\,16^m$		$21^h\,15^m$		

TABLE 45.

Haversines.

s	$2^h\,45^m$ 41° 15′		$2^h\,46^m$ 41° 30′		$2^h\,47^m$ 41° 45′		$2^h\,48^m$ 42° 0′		$2^h\,49^m$ 42° 15′		s
	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	
0	9.09370	.12408	9.09872	.12552	9.10371	.12697	9.10866	.12843	9.11358	.12989	60
1	.09379	.12410	.09880	.12555	.10379	.12700	.10874	.12845	.11366	.12992	59
2	.09387	.12413	.09889	.12557	.10387	.12702	.10882	.12848	.11374	.12994	58
3	.09395	.12415	.09897	.12559	.10395	.12704	.10891	.12850	.11382	.12996	57
+ 1′	9.09404	.12418	9.09905	.12562	9.10404	.12707	9.10899	.12852	9.11391	.12999	56
5	.09412	.12420	.09914	.12564	.10412	.12709	.10907	.12855	.11399	.13001	55
6	.09421	.12422	.09922	.12567	.10420	.12712	.10915	.12857	.11407	.13004	54
7	.09429	.12425	.09930	.12569	.10429	.12714	.10923	.12860	.11415	.13006	53
+ 2′	9.09437	.12427	9.09939	.12572	9.10437	.12717	9.10932	.12862	9.11423	.13009	52
9	.09446	.12430	.09947	.12574	.10445	.12719	.10940	.12865	.11431	.13011	51
10	.09454	.12432	.09955	.12576	.10453	.12721	.10948	.12867	.11440	.13014	50
11	.09462	.12434	.09964	.12579	.10462	.12724	.10956	.12870	.11448	.13016	49
+ 3′	9.09471	.12437	9.09972	.12581	9.10470	.12726	9.10965	.12872	9.11456	.13018	48
13	.09479	.12439	.09980	.12584	.10478	.12729	.10973	.12874	.11464	.13021	47
14	.09488	.12442	.09989	.12586	.10486	.12731	.10981	.12877	.11472	.13023	46
15	.09496	.12444	.09997	.12588	.10495	.12733	.10989	.12879	.11480	.13026	45
+ 4′	9.09504	.12446	9.10005	.12591	9.10503	.12736	9.10997	.12882	9.11489	.13028	44
17	.09513	.12449	.10014	.12593	.10511	.12738	.11006	.12884	.11497	.13031	43
18	.09521	.12451	.10022	.12596	.10519	.12741	.11014	.12887	.11505	.13033	42
19	.09529	.12454	.10030	.12598	.10528	.12743	.11022	.12889	.11513	.13036	41
+ 5′	9.09538	.12456	9.10039	.12600	9.10536	.12746	9.11030	.12891	9.11521	.13038	40
21	.09546	.12458	.10047	.12603	.10544	.12748	.11038	.12894	.11529	.13041	39
22	.09555	.12461	.10055	.12605	.10553	.12750	.11047	.12896	.11538	.13043	38
23	.09563	.12463	.10064	.12608	.10561	.12753	.11055	.12899	.11546	.13045	37
+ 6′	9.09571	.12466	9.10072	.12610	9.10569	.12755	9.11063	.12901	9.11554	.13048	36
25	.09580	.12468	.10080	.12613	.10577	.12758	.11071	.12904	.11562	.13050	35
26	.09588	.12470	.10088	.12615	.10586	.12760	.11079	.12906	.11570	.13053	34
27	.09596	.12473	.10097	.12617	.10594	.12763	.11088	.12909	.11578	.13055	33
+ 7′	9.09605	.12475	9.10105	.12620	9.10602	.12765	9.11096	.12911	9.11586	.13058	32
29	.09613	.12478	.10113	.12622	.10610	.12767	.11104	.12913	.11595	.13060	31
30	.09622	.12480	.10122	.12625	.10619	.12770	.11112	.12916	.11603	.13063	30
31	.09630	.12482	.10130	.12627	.10627	.12772	.11120	.12918	.11611	.13065	29
+ 8′	9.09638	.12485	9.10138	.12629	9.10635	.12775	9.11129	.12921	9.11619	.13067	28
33	.09647	.12487	.10147	.12632	.10643	.12777	.11137	.12923	.11627	.13070	27
34	.09655	.12490	.10155	.12634	.10652	.12780	.11145	.12926	.11635	.13072	26
35	.09663	.12492	.10163	.12637	.10660	.12782	.11153	.12928	.11643	.13075	25
+ 9′	9.09672	.12494	9.10172	.12639	9.10668	.12784	9.11161	.12930	9.11652	.13077	24
37	.09680	.12497	.10180	.12641	.10676	.12787	.11170	.12933	.11660	.13080	23
38	.09688	.12499	.10188	.12644	.10685	.12789	.11178	.12935	.11668	.13082	22
39	.09697	.12502	.10196	.12646	.10693	.12792	.11186	.12938	.11676	.13085	21
+ 10′	9.09705	.12504	9.10205	.12649	9.10701	.12794	9.11194	.12940	9.11684	.13087	20
41	.09713	.12506	.10213	.12651	.10709	.12797	.11202	.12943	.11692	.13090	19
42	.09722	.12509	.10221	.12654	.10718	.12799	.11211	.12945	.11700	.13092	18
43	.09730	.12511	.10230	.12656	.10726	.12801	.11219	.12948	.11709	.13095	17
+ 11′	9.09739	.12514	9.10238	.12658	9.10734	.12804	9.11227	.12950	9.11717	.13097	16
45	.09747	.12516	.10246	.12661	.10742	.12806	.11235	.12952	.11725	.13099	15
46	.09755	.12519	.10255	.12663	.10751	.12809	.11243	.12955	.11733	.13102	14
47	.09764	.12521	.10263	.12666	.10759	.12811	.11252	.12957	.11741	.13104	13
+ 12′	9.09772	.12523	9.10271	.12668	9.10767	.12814	9.11260	.12960	9.11749	.13107	12
49	.09780	.12526	.10279	.12671	.10775	.12816	.11268	.12962	.11757	.13109	11
50	.09789	.12528	.10288	.12673	.10784	.12818	.11276	.12965	.11766	.13112	10
51	.09797	.12531	.10296	.12675	.10792	.12821	.11284	.12967	.11774	.13114	9
+ 13′	9.09805	.12533	9.10304	.12678	9.10800	.12823	9.11292	.12970	9.11782	.13116	8
53	.09814	.12535	.10313	.12680	.10808	.12826	.11301	.12972	.11790	.13119	7
54	.09822	.12538	.10321	.12683	.10816	.12828	.11309	.12974	.11798	.13121	6
55	.09830	.12540	.10329	.12685	.10825	.12831	.11317	.12977	.11806	.13124	5
+ 14′	9.09839	.12543	9.10337	.12687	9.10833	.12833	9.11325	.12979	9.11814	.13126	4
57	.09847	.12545	.10346	.12690	.10841	.12836	.11333	.12982	.11822	.13129	3
58	.09856	.12547	.10354	.12692	.10849	.12838	.11342	.12984	.11831	.13131	2
59	.09864	.12550	.10362	.12695	.10858	.12840	.11350	.12987	.11839	.13134	1
+ 15′	9.09872	.12552	9.10371	.12697	9.10866	.12843	9.11358	.12989	9.11847	.13136	0
	$21^h\,14^m$		$21^h\,13^m$		$21^h\,12^m$		$21^h\,11^m$		$21^h\,10^m$		

TABLE 45.

Haversines.

s	2h 50m 42° 30′		2h 51m 42° 45′		2h 52m 43° 0′		2h 53m 4
	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.
0	9.11847	.13136	9.12332	.13284	9.12815	.13432	9.13295
1	.11855	.13139	.12341	.13286	.12823	.13435	.13303
2	.11863	.13141	.12349	.13289	.12831	.13437	.13311
3	.11871	.13143	.12357	.13291	.12839	.13440	.13319
+ 1′	9.11879	.13146	9.12365	.13294	9.12847	.13442	9.13326
5	.11887	.13148	.12373	.13296	.12855	.13445	.13334
6	.11895	.13151	.12381	.13299	.12863	.13447	.13342
7	.11904	.13153	.12389	.13301	.12871	.13450	.13350
+ 2′	9.11912	.13156	9.12397	.13304	9.12879	.13452	9.13358
9	.11920	.13158	.12405	.13306	.12887	.13455	.13366
10	.11928	.13161	.12413	.13309	.12895	.13457	.13374
11	.11936	.13163	.12421	.13311	.12903	.13460	.13382
+ 3′	9.11944	.13166	9.12429	.13314	9.12911	.13462	9.13390
13	.11952	.13168	.12437	.13316	.12919	.13465	.13398
14	.11960	.13171	.12445	.13318	.12927	.13467	.13406
15	.11968	.13173	.12453	.13321	.12935	.13470	.13414
+ 4′	9.11977	.13175	9.12461	.13323	9.12943	.13472	9.13422
17	.11985	.13178	.12470	.13326	.12951	.13474	.13430
18	.11993	.13180	.12478	.13328	.12959	.13477	.13438
19	.12001	.13183	.12486	.13331	.12967	.13479	.13446
+ 5′	9.12009	.13185	9.12494	.13333	9.12975	.13482	9.13454
21	.12017	.13188	.12502	.13336	.12983	.13484	.13462
22	.12025	.13190	.12510	.13338	.12991	.13487	.13470
23	.12033	.13193	.12518	.13341	.12999	.13489	.13478
+ 6′	9.12041	.13195	9.12526	.13343	9.13007	.13492	9.13486
25	.12050	.13198	.12534	.13346	.13015	.13494	.13494
26	.12058	.13200	.12542	.13348	.13023	.13497	.13501
27	.12066	.13203	.12550	.13351	.13031	.13499	.13509
+ 7′	9.12074	.13205	9.12558	.13353	9.13039	.13502	9.13517
29	.12082	.13207	.12566	.13356	.13047	.13504	.13525
30	.12090	.13210	.12574	.13358	.13055	.13507	.13533
31	.12098	.13212	.12582	.13360	.13063	.13509	.13541
+ 8′	9.12106	.13215	9.12590	.13363	9.13071	.13512	9.13549
33	.12114	.13217	.12598	.13365	.13079	.13514	.13557
34	.12122	.13220	.12606	.13368	.13087	.13517	.13565
35	.12130	.13222	.12614	.13370	.13095	.13519	.13573
+ 9′	9.12139	.13225	9.12622	.13373	9.13103	.13522	9.13581
37	.12147	.13227	.12630	.13375	.13111	.13524	.13589
38	.12155	.13230	.12638	.13378	.13119	.13527	.13597
39	.12163	.13232	.12647	.13380	.13127	.13529	.13605
+ 10′	9.12171	.13235	9.12655	.13383	9.13135	.13532	9.13613
41	.12179	.13237	.12663	.13385	.13143	.13534	.13621
42	.12187	.13239	.12671	.13388	.13151	.13537	.13628
43	.12195	.13242	.12679	.13390	.13159	.13539	.13636
+ 11′	9.12203	.13244	9.12687	.13393	9.13167	.13542	9.13644
45	.12211	.13247	.12695	.13395	.13175	.13544	.13652
46	.12219	.13249	.12703	.13398	.13183	.13547	.13660
47	.12228	.13252	.12711	.13400	.13191	.13549	.13668
+ 12′	9.12236	.13254	9.12719	.13403	9.13199	.13552	9.13676
49	.12244	.13257	.12727	.13405	.13207	.13554	.13684
50	.12252	.13259	.12735	.13408	.13215	.13557	.13692
51	.12260	.13262	.12743	.13410	.13223	.13559	.13700
+ 13′	9.12268	.13264	9.12751	.13412	9.13231	.13562	9.13708
53	.12276	.13267	.12759	.13415	.13239	.13564	.13716
54	.12284	.13269	.12767	.13417	.13247	.13567	.13724
55	.12292	.13272	.12775	.13420	.13255	.13569	.13732
+ 14′	9.12300	.13274	9.12783	.13422	9.13263	.13571	9.13739
57	.12308	.13276	.12791	.13425	.13271	.13574	.13747
58	.12316	.13279	.12799	.13427	.13279	.13576	.13755
59	.12324	.13281	.12807	.13430	.13287	.13579	.13763
+ 15′	9.12332	.13284	9.12815	.13432	9.13295	.13581	9.13771
	21h 9m		21h 8m		21h 7m		21h

TABLE 45.

Haversines.

s	2h 55m 43° 45′		2h 56m 44° 0′		2h 57m 44° 15′		2h 58m 44° 30′		2h 59m 44° 45′		s
	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	s
0	9.14245	.13882	9.14715	.14033	9.15183	.14185	9.15647	.14337	9.16109	.14491	60
1	.14252	.13884	.14723	.14035	.15190	.14187	.15655	.14340	.16117	.14493	59
2	.14260	.13887	.14731	.14038	.15198	.14190	.15663	.14343	.16124	.14496	58
3	.14268	.13889	.14739	.14041	.15206	.14192	.15670	.14345	.16132	.14498	57
+ 1′	9.14276	.13892	9.14746	.14043	9.15214	.14195	9.15678	.14348	9.16140	.14501	56
5	.14284	.13894	.14754	.14046	.15221	.14198	.15686	.14350	.16147	.14504	55
6	.14292	.13897	.14762	.14048	.15229	.14200	.15694	.14353	.16155	.14506	54
7	.14300	.13899	.14770	.14051	.15237	.14203	.15701	.14355	.16163	.14509	53
+ 2′	9.14307	.13902	9.14778	.14053	9.15245	.14205	9.15709	.14358	9.16170	.14511	52
9	.14315	.13904	.14785	.14056	.15253	.14208	.15717	.14360	.16178	.14514	51
10	.14323	.13907	.14793	.14058	.15260	.14210	.15724	.14363	.16186	.14516	50
11	.14331	.13909	.14801	.14061	.15268	.14213	.15732	.14366	.16193	.14519	49
+ 3′	9.14339	.13912	9.14809	.14063	9.15276	.14215	9.15740	.14368	9.16201	.14521	48
13	.14347	.13914	.14817	.14066	.15284	.14218	.15748	.14371	.16209	.14524	47
14	.14355	.13917	.14824	.14068	.15291	.14220	.15755	.14373	.16216	.14527	46
15	.14362	.13920	.14832	.14071	.15299	.14223	.15763	.14376	.16224	.14529	45
+ 4′	9.14370	.13922	9.14840	.14073	9.15307	.14226	9.15771	.14378	9.16232	.14532	44
17	.14378	.13925	.14848	.14076	.15315	.14228	.15778	.14381	.16239	.14534	43
18	.14386	.13927	.14856	.14078	.15322	.14231	.15786	.14383	.16247	.14537	42
19	.14394	.13930	.14863	.14081	.15330	.14233	.15794	.14386	.16255	.14539	41
+ 5′	9.14402	.13932	9.14871	.14084	9.15338	.14236	9.15802	.14388	9.16262	.14542	40
21	.14410	.13935	.14879	.14086	.15346	.14238	.15809	.14391	.16270	.14545	39
22	.14417	.13937	.14887	.14089	.15353	.14241	.15817	.14394	.16278	.14547	38
23	.14425	.13940	.14895	.14091	.15361	.14243	.15825	.14396	.16285	.14550	37
+ 6′	9.14433	.13942	9.14902	.14094	9.15369	.14246	9.15832	.14399	9.16293	.14552	36
25	.14441	.13945	.14910	.14096	.15377	.14248	.15840	.14401	.16301	.14555	35
26	.14449	.13947	.14918	.14099	.15384	.14251	.15848	.14404	.16308	.14557	34
27	.14457	.13950	.14926	.14101	.15392	.14253	.15855	.14406	.16316	.14560	33
+ 7′	9.14465	.13952	9.14934	.14104	9.15400	.14256	9.15863	.14409	9.16324	.14562	32
29	.14472	.13955	.14941	.14106	.15408	.14259	.15871	.14411	.16331	.14565	31
30	.14480	.13957	.14949	.14109	.15415	.14261	.15879	.14414	.16339	.14568	30
31	.14488	.13960	.14957	.14111	.15423	.14264	.15886	.14417	.16346	.14570	29
+ 8′	9.14496	.13962	9.14965	.14114	9.15431	.14266	9.15894	.14419	9.16354	.14573	28
33	.14504	.13965	.14973	.14116	.15439	.14269	.15902	.14422	.16362	.14575	27
34	.14512	.13967	.14980	.14119	.15446	.14271	.15909	.14424	.16369	.14578	26
35	.14519	.13970	.14988	.14122	.15454	.14274	.15917	.14427	.16377	.14580	25
+ 9′	9.14527	.13972	9.14996	.14124	9.15462	.14276	9.15925	.14429	9.16385	.14583	24
37	.14535	.13975	.15004	.14127	.15470	.14279	.15932	.14432	.16392	.14586	23
38	.14543	.13977	.15012	.14129	.15477	.14281	.15940	.14434	.16400	.14588	22
39	.14551	.13980	.15019	.14132	.15485	.14284	.15948	.14437	.16408	.14591	21
+ 10′	9.14559	.13983	9.15027	.14134	9.15493	.14287	9.15955	.14440	9.16415	.14593	20
41	.14566	.13985	.15035	.14137	.15500	.14289	.15963	.14442	.16423	.14596	19
42	.14574	.13988	.15043	.14139	.15508	.14292	.15971	.14445	.16431	.14598	18
43	.14582	.13990	.15050	.14142	.15516	.14294	.15978	.14447	.16438	.14601	17
+ 11′	9.14590	.13993	9.15058	.14144	9.15524	.14297	9.15986	.14450	9.16446	.14604	16
45	.14598	.13995	.15066	.14147	.15531	.14299	.15994	.14452	.16453	.14606	15
46	.14606	.13998	.15074	.14149	.15539	.14302	.16002	.14455	.16461	.14609	14
47	.14613	.14000	.15082	.14152	.15547	.14304	.16009	.14457	.16469	.14611	13
+ 12′	9.14621	.14003	9.15089	.14154	9.15555	.14307	9.16017	.14460	9.16476	.14614	12
49	.14629	.14005	.15097	.14157	.15562	.14309	.16025	.14463	.16484	.14616	11
50	.14637	.14008	.15105	.14160	.15570	.14312	.16032	.14465	.16492	.14619	10
51	.14645	.14010	.15113	.14162	.15578	.14315	.16040	.14468	.16499	.14622	9
+ 13′	9.14653	.14013	9.15120	.14165	9.15585	.14317	9.16048	.14470	9.16507	.14624	8
53	.14660	.14015	.15128	.14167	.15593	.14320	.16055	.14473	.16515	.14627	7
54	.14668	.14018	.15136	.14170	.15601	.14322	.16063	.14475	.16522	.14629	6
55	.14676	.14020	.15144	.14172	.15609	.14325	.16071	.14478	.16530	.14632	5
+ 14′	9.14684	.14023	9.15152	.14175	9.15616	.14327	9.16078	.14480	9.16537	.14634	4
57	.14692	.14025	.15159	.14177	.15624	.14330	.16086	.14483	.16545	.14637	3
58	.14699	.14028	.15167	.14180	.15632	.14332	.16094	.14486	.16553	.14639	2
59	.14707	.14030	.15175	.14182	.15640	.14335	.16101	.14488	.16560	.14642	1
+ 15′	9.14715	.14033	9.15183	.14185	9.15647	.14337	9.16109	.14491	9.16568	.14645	0
	21h 4m		21h 3m		21h 2m		21h 1m		21h 0m		

TABLE 45.

Haversines.

	$3^h\ 0^m$ 45° 0′		$3^h\ 1^m$ 45° 15′		$3^h\ 2^m$ 45° 30′		$3^h\ 3^m$ 4
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.
0	9.16568	.14645	9.17024	.14799	9.17477	.14955	9.17928
1	.16576	.14647	.17032	.14802	.17485	.14957	.17935
2	.16583	.14650	.17039	.14804	.17492	.14960	.17943
3	.16591	.14652	.17047	.14807	.17500	.14962	.17950
+ 1′	9.16598	.14655	9.17054	.14810	9.17507	.14965	9.17958
5	.16606	.14658	.17062	.14812	.17515	.14968	.17965
6	.16614	.14660	.17069	.14815	.17522	.14970	.17973
7	.16621	.14663	.17077	.14817	.17530	.14973	.17980
+ 2′	9.16629	.14665	9.17085	.14820	9.17538	.14975	9.17988
9	.16637	.14668	.17092	.14822	.17545	.14978	.17995
10	.16644	.14670	.17100	.14825	.17553	.14981	.18003
11	.16652	.14673	.17107	.14828	.17560	.14983	.18010
+ 3′	9.16659	.14676	9.17115	.14830	9.17568	.14986	9.18018
13	.16667	.14678	.17122	.14833	.17575	.14988	.18025
14	.16675	.14681	.17130	.14835	.17583	.14991	.18033
15	.16682	.14683	.17138	.14838	.17590	.14993	.18040
+ 4′	9.16690	.14686	9.17145	.14841	9.17598	.14996	9.18048
17	.16697	.14688	.17153	.14843	.17605	.14999	.18055
18	.16705	.14691	.17160	.14846	.17613	.15001	.18062
19	.16713	.14693	.17168	.14848	.17620	.15004	.18070
+ 5′	9.16720	.14696	9.17175	.14851	9.17628	.15006	9.18077
21	.16728	.14699	.17183	.14853	.17635	.15009	.18085
22	.16735	.14701	.17191	.14856	.17643	.15012	.18092
23	.16743	.14704	.17198	.14858	.17650	.15014	.18100
+ 6′	9.16751	.14706	9.17206	.14861	9.17658	.15017	9.18107
25	.16758	.14709	.17213	.14864	.17665	.15019	.18115
26	.16766	.14712	.17221	.14866	.17673	.15022	.18122
27	.16774	.14714	.17228	.14869	.17680	.15025	.18130
+ 7′	9.16781	.14717	9.17236	.14872	9.17688	.15027	9.18137
29	.16789	.14719	.17243	.14874	.17695	.15030	.18145
30	.16796	.14722	.17251	.14877	.17703	.15032	.18152
31	.16804	.14724	.17259	.14879	.17710	.15035	.18160
+ 8′	9.16812	.14727	9.17266	.14882	9.17718	.15038	9.18167
33	.16819	.14730	.17274	.14885	.17725	.15040	.18174
34	.16827	.14732	.17281	.14887	.17733	.15043	.18182
35	.16834	.14735	.17289	.14890	.17740	.15045	.18189
+ 9′	9.16842	.14737	9.17296	.14892	9.17748	.15048	9.18197
37	.16850	.14740	.17304	.14895	.17755	.15051	.18204
38	.16857	.14743	.17311	.14898	.17763	.15053	.18212
39	.16865	.14745	.17319	.14900	.17770	.15056	.18219
+ 10′	9.16872	.14748	9.17327	.14903	9.17778	.15058	9.18227
41	.16880	.14750	.17334	.14905	.17785	.15061	.18234
42	.16887	.14753	.17342	.14908	.17793	.15064	.18242
43	.16895	.14755	.17349	.14910	.17800	.15066	.18249
+ 11′	9.16903	.14758	9.17357	.14913	9.17808	.15069	9.18256
45	.16910	.14760	.17364	.14916	.17815	.15071	.18264
46	.16918	.14763	.17372	.14918	.17823	.15074	.18271
47	.16925	.14766	.17379	.14921	.17830	.15077	.18279
+ 12′	9.16933	.14768	9.17387	.14923	9.17838	.15079	9.18286
49	.16941	.14771	.17394	.14926	.17845	.15082	.18294
50	.16948	.14773	.17402	.14929	.17853	.15084	.18301
51	.16956	.14776	.17409	.14931	.17860	.15087	.18309
+ 13′	9.16963	.14779	9.17417	.14934	9.17868	.15090	9.18316
53	.16971	.14781	.17425	.14936	.17875	.15092	.18324
54	.16979	.14784	.17432	.14939	.17883	.15095	.18331
55	.16986	.14786	.17440	.14942	.17890	.15097	.18338
+ 14′	9.16994	.14789	9.17447	.14944	9.17898	.15100	9.18346
57	.17001	.14791	.17455	.14947	.17905	.15103	.18353
58	.17009	.14794	.17462	.14949	.17913	.15105	.18361
59	.17016	.14797	.17470	.14952	.17920	.15108	.18368
+ 15′	9.17024	.14799	9.17477	.14955	9.17928	.15110	9.18376
	$20^h\ 59^m$		$20^h\ 58^m$		$20^h\ 57^m$		$20^h\ 5$

TABLE 45.

Haversines.

	$3^h 5^m$ 46° 15′		$3^h 6^m$ 46° 30′		$3^h 7^m$ 46° 45′		$3^h 8^m$ 47° 0′		$3^h 9^m$ 47° 15′		
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	s
0	9.18821	.15424	9.19263	.15582	9.19703	.15741	9.20140	.15900	9.20574	.16060	60
1	.18828	.15427	.19270	.15585	.19710	.15743	.20147	.15903	.20582	.16063	59
2	.18835	.15430	.19278	.15588	.19717	.15746	.20154	.15905	.20589	.16065	58
3	.18843	.15432	.19285	.15590	.19725	.15748	.20162	.15908	.20596	.16068	57
+ 1′	9.18850	.15435	9.19292	.15593	9.19732	.15751	9.20169	.15911	9.20603	.16071	56
5	.18858	.15437	.19300	.15595	.19739	.15754	.20176	.15913	.20611	.16073	55
6	.18865	.15440	.19307	.15598	.19747	.15757	.20184	.15916	.20618	.16076	54
7	.18872	.15443	.19315	.15601	.19754	.15759	.20191	.15919	.20625	.16079	53
+ 2′	9.18880	.15445	9.19322	.15603	9.19761	.15762	9.20198	.15921	9.20632	.16081	52
9	.18887	.15448	.19329	.15606	.19769	.15765	.20205	.15924	.20639	.16084	51
10	.18895	.15451	.19337	.15609	.19776	.15767	.20213	.15927	.20647	.16087	50
11	.18902	.15453	.19344	.15611	.19783	.15770	.20220	.15929	.20654	.16089	49
+ 3′	9.18909	.15456	9.19351	.15614	9.19790	.15773	9.20227	.15932	9.20661	.16092	48
13	.18917	.15458	.19359	.15617	.19798	.15775	.20234	.15935	.20668	.16095	47
14	.18924	.15461	.19366	.15619	.19805	.15778	.20242	.15937	.20675	.16097	46
15	.18932	.15464	.19373	.15622	.19812	.15781	.20249	.15940	.20683	.16100	45
+ 4′	9.18939	.15466	9.19381	.15625	9.19820	.15783	9.20256	.15943	9.20690	.16103	44
17	.18946	.15469	.19388	.15627	.19827	.15786	.20263	.15945	.20697	.16105	43
18	.18954	.15472	.19395	.15630	.19834	.15789	.20271	.15948	.20704	.16108	42
19	.18961	.15474	.19403	.15632	.19842	.15791	.20278	.15951	.20712	.16111	41
+ 5′	9.18968	.15477	9.19410	.15635	9.19849	.15794	9.20285	.15953	9.20719	.16113	40
21	.18976	.15479	.19417	.15638	.19856	.15796	.20292	.15956	.20726	.16116	39
22	.18983	.15482	.19425	.15640	.19863	.15799	.20300	.15959	.20733	.16119	38
23	.18991	.15485	.19432	.15643	.19871	.15802	.20307	.15961	.20740	.16121	37
+ 6′	9.18998	.15487	9.19439	.15646	9.19878	.15804	9.20314	.15964	9.20748	.16124	36
25	.19005	.15490	.19447	.15648	.19885	.15807	.20321	.15967	.20755	.16127	35
26	.19013	.15493	.19454	.15651	.19893	.15810	.20329	.15969	.20762	.16129	34
27	.19020	.15495	.19461	.15654	.19900	.15812	.20336	.15972	.20769	.16132	33
+ 7′	9.19027	.15498	9.19469	.15656	9.19907	.15815	9.20343	.15975	9.20776	.16135	32
29	.19035	.15501	.19476	.15659	.19914	.15818	.20350	.15977	.20784	.16137	31
30	.19042	.15503	.19483	.15662	.19922	.15820	.20358	.15980	.20791	.16140	30
31	.19050	.15506	.19491	.15664	.19929	.15823	.20365	.15983	.20798	.16143	29
+ 8′	9.19057	.15509	9.19498	.15667	9.19936	.15826	9.20372	.15985	9.20805	.16146	28
33	.19064	.15511	.19505	.15670	.19944	.15828	.20379	.15988	.20812	.16148	27
34	.19072	.15514	.19513	.15672	.19951	.15831	.20386	.15991	.20820	.16151	26
35	.19079	.15516	.19520	.15675	.19958	.15834	.20394	.15993	.20827	.16154	25
+ 9′	9.19086	.15519	9.19527	.15677	9.19965	.15836	9.20401	.15996	9.20834	.16156	24
37	.19094	.15522	.19535	.15680	.19973	.15839	.20408	.15999	.20841	.16159	23
38	.19101	.15524	.19542	.15683	.19980	.15842	.20415	.16001	.20848	.16162	22
39	.19109	.15527	.19549	.15685	.19987	.15844	.20423	.16004	.20856	.16164	21
+ 10′	9.19116	.15530	9.19557	.15688	9.19995	.15847	9.20430	.16007	9.20863	.16167	20
41	.19123	.15532	.19564	.15691	.20002	.15850	.20437	.16009	.20870	.16170	19
42	.19131	.15535	.19571	.15693	.20009	.15852	.20444	.16012	.20877	.16172	18
43	.19138	.15537	.19579	.15696	.20016	.15855	.20452	.16015	.20884	.16175	17
+ 11′	9.19145	.15540	9.19586	.15699	9.20024	.15858	9.20459	.16017	9.20891	.16178	16
45	.19153	.15543	.19593	.15701	.20031	.15860	.20466	.16020	.20899	.16180	15
46	.19160	.15545	.19600	.15704	.20038	.15863	.20473	.16023	.20906	.16183	14
47	.19167	.15548	.19608	.15706	.20045	.15866	.20481	.16025	.20913	.16186	13
+ 12′	9.19175	.15551	9.19615	.15709	9.20053	.15868	9.20488	.16028	9.20920	.16188	12
49	.19182	.15553	.19622	.15712	.20060	.15871	.20495	.16031	.20927	.16191	11
50	.19190	.15556	.19630	.15714	.20067	.15874	.20502	.16033	.20935	.16194	10
51	.19197	.15559	.19637	.15717	.20075	.15876	.20509	.16036	.20942	.16196	9
+ 13′	9.19204	.15561	9.19644	.15720	9.20082	.15879	9.20517	.16039	9.20949	.16199	8
53	.19212	.15564	.19652	.15722	.20089	.15881	.20524	.16041	.20956	.16202	7
54	.19219	.15566	.19659	.15725	.20096	.15884	.20531	.16044	.20963	.16204	6
55	.19226	.15569	.19666	.15728	.20104	.15887	.20538	.16047	.20971	.16207	5
+ 14′	9.19234	.15572	9.19674	.15730	9.20111	.15889	9.20546	.16049	9.20978	.16210	4
57	.19241	.15574	.19681	.15733	.20118	.15892	.20553	.16052	.20985	.16212	3
58	.19248	.15577	.19688	.15736	.20125	.15895	.20560	.16055	.20992	.16215	2
59	.19256	.15580	.19696	.15738	.20133	.15898	.20567	.16057	.20999	.16218	1
+ 15′	9.19263	.15582	9.19703	.15741	9.20140	.15900	9.20574	.16060	9.21006	.16220	0
	$20^h 54^m$		$20^h 53^m$		$20^h 52^m$		$20^h 51^m$		$20^h 50^m$		

TABLE 45.

Haversines.

	3^h 10^m 47° 30′		3^h 11^m 47° 45′		3^h 12^m 48° 0′		3^h 13^m
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.
0	9.21006	**.16220**	9.21436	**.16382**	9.21863	**.16543**	9.22287
1	.21014	**.16223**	.21443	**.16384**	.21870	**.16546**	.22294
2	.21021	**.16226**	.21450	**.16387**	.21877	**.16549**	.22301
3	.21028	**.16229**	.21457	**.16390**	.21884	**.16552**	.22308
+ 1′	9.21035	**.16231**	9.21464	**.16392**	9.21891	**.16554**	9.22315
5	.21042	**.16234**	.21471	**.16395**	.21898	**.16557**	.22322
6	.21049	**.16237**	.21479	**.16398**	.21905	**.16560**	.22329
7	.21057	**.16239**	.21486	**.16401**	.21912	**.16562**	.22336
+ 2′	9.21064	**.16242**	9.21493	**.16403**	9.21919	**.16565**	9.22343
9	.21071	**.16245**	.21500	**.16406**	.21926	**.16568**	.22350
10	.21078	**.16247**	.21507	**.16409**	.21934	**.16571**	.22358
11	.21085	**.16250**	.21514	**.16411**	.21941	**.16573**	.22365
+ 3′	9.21092	**.16253**	9.21521	**.16414**	9.21948	**.16576**	9.22372
13	.21100	**.16255**	.21529	**.16417**	.21955	**.16579**	.22379
14	.21107	**.16258**	.21536	**.16419**	.21962	**.16581**	.22386
15	.21114	**.16261**	.21543	**.16422**	.21969	**.16584**	.22393
+ 4′	9.21121	**.16263**	9.21550	**.16425**	9.21976	**.16587**	9.22400
17	.21128	**.16266**	.21557	**.16427**	.21983	**.16589**	.22407
18	.21135	**.16269**	.21564	**.16430**	.21990	**.16592**	.22414
19	.21143	**.16271**	.21571	**.16433**	.21997	**.16595**	.22421
+ 5′	9.21150	**.16274**	9.21578	**.16436**	9.22004	**.16598**	9.22428
21	.21157	**.16277**	.21585	**.16438**	.22011	**.16600**	.22435
22	.21164	**.16280**	.21593	**.16441**	.22019	**.16603**	.22442
23	.21171	**.16282**	.21600	**.16444**	.22026	**.16606**	.22449
+ 6′	9.21178	**.16285**	9.21607	**.16446**	9.22033	**.16608**	9.22456
25	.21186	**.16288**	.21614	**.16449**	.22040	**.16611**	.22463
26	.21193	**.16290**	.21621	**.16452**	.22047	**.16614**	.22470
27	.21200	**.16293**	.21628	**.16454**	.22054	**.16616**	.22477
+ 7′	9.21207	**.16296**	9.21635	**.16457**	9.22061	**.16619**	9.22484
29	.21214	**.16298**	.21642	**.16460**	.22068	**.16622**	.22491
30	.21221	**.16301**	.21650	**.16462**	.22075	**.16625**	.22498
31	.21229	**.16304**	.21657	**.16465**	.22082	**.16627**	.22505
+ 8′	9.21236	**.16306**	9.21664	**.16468**	9.22089	**.16630**	9.22512
33	.21243	**.16309**	.21671	**.16471**	.22096	**.16633**	.22519
34	.21250	**.16312**	.21678	**.16473**	.22103	**.16635**	.22526
35	.21257	**.16314**	.21685	**.16476**	.22111	**.16638**	.22533
+ 9′	9.21264	**.16317**	9.21692	**.16479**	9.22118	**.16641**	9.22540
37	.21272	**.16320**	.21699	**.16481**	.22125	**.16644**	.22547
38	.21279	**.16323**	.21706	**.16484**	.22132	**.16646**	.22555
39	.21286	**.16325**	.21714	**.16487**	.22139	**.16649**	.22562
+ 10′	9.21293	**.16328**	9.21721	**.16489**	9.22146	**.16652**	9.22569
41	.21300	**.16331**	.21728	**.16492**	.22153	**.16654**	.22576
42	.21307	**.16333**	.21735	**.16495**	.22160	**.16657**	.22583
43	.21314	**.16336**	.21742	**.16498**	.22167	**.16660**	.22590
+ 11′	9.21322	**.16339**	9.21749	**.16500**	9.22174	**.16663**	9.22597
45	.21329	**.16341**	.21756	**.16503**	.22181	**.16665**	.22604
46	.21336	**.16344**	.21763	**.16506**	.22188	**.16668**	.22611
47	.21343	**.16347**	.21770	**.16508**	.22195	**.16671**	.22618
+ 12′	9.21350	**.16349**	9.21778	**.16511**	9.22202	**.16673**	9.22625
49	.21357	**.16352**	.21785	**.16514**	.22209	**.16676**	.22632
50	.21364	**.16355**	.21792	**.16516**	.22216	**.16679**	.22639
51	.21372	**.16357**	.21799	**.16519**	.22224	**.16681**	.22646
+ 13′	9.21379	**.16360**	9.21806	**.16522**	9.22231	**.16684**	9.22653
53	.21386	**.16363**	.21813	**.16524**	.22238	**.16687**	.22660
54	.21393	**.16366**	.21820	**.16527**	.22245	**.16690**	.22667
55	.21400	**.16368**	.21827	**.16530**	.22252	**.16692**	.22674
+ 14′	9.21407	**.16371**	9.21834	**.16533**	9.22259	**.16695**	9.22681
57	.21414	**.16374**	.21841	**.16535**	.22266	**.16698**	.22688
58	.21422	**.16376**	.21848	**.16538**	.22273	**.16701**	.22695
59	.21429	**.16379**	.21856	**.16541**	.22280	**.16703**	.22702
+ 15′	9.21436	**.16382**	9.21863	**.16543**	9.22287	**.16706**	9.22709
	20^h 49^m		20^h 48^m		20^h 47^m		20^h

TABLE 45.

Haversines.

	3h 15m 48° 45′		*3h 16m* 49° 0′		*3h 17m* 49° 15′		*3h 18m* 49° 30′		*3h 19m* 49° 45′		
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	s
0	9.23128	.17033	9.23545	.17197	9.23960	.17362	9.24372	.17528	9.24782	.17694	*60*
1	.23135	.17035	.23552	.17200	.23967	.17365	.24379	.17530	.24789	.17697	*59*
2	.23142	.17038	.23559	.17202	.23974	.17368	.24386	.17533	.24796	.17700	*58*
3	.23149	.17041	.23566	.17205	.23981	.17370	.24393	.17536	.24803	.17702	*57*
+ 1′	9.23156	.17044	9.23573	.17208	9.23988	.17373	9.24400	.17539	9.24809	.17705	*56*
5	.23163	.17046	.23580	.17211	.23994	.17376	.24406	.17541	.24816	.17708	*55*
6	.23170	.17049	.23587	.17214	.24001	.17379	.24413	.17544	.24823	.17710	*54*
7	.23177	.17052	.23594	.17216	.24008	.17381	.24420	.17547	.24830	.17713	*53*
+ 2′	9.23184	.17055	9.23601	.17219	9.24015	.17384	9.24427	.17550	9.24837	.17716	*52*
9	.23191	.17057	.23608	.17222	.24022	.17387	.24434	.17552	.24843	.17719	*51*
10	.23198	.17060	.23615	.17225	.24029	.17390	.24441	.17555	.24850	.17722	*50*
11	.23205	.17063	.23622	.17227	.24036	.17392	.24448	.17558	.24857	.17724	*49*
+ 3′	9.23212	.17066	9.23629	.17230	9.24043	.17395	9.24454	.17561	9.24864	.17727	*48*
13	.23219	.17068	.23635	.17233	.24050	.17398	.24461	.17563	.24871	.17730	*47*
14	.23226	.17071	.23642	.17235	.24056	.17401	.24468	.17566	.24877	.17733	*46*
15	.23233	.17074	.23649	.17238	.24063	.17403	.24475	.17569	.24884	.17735	*45*
+ 4′	9.23240	.17076	9.23656	.17241	9.24070	.17406	9.24482	.17572	9.24891	.17738	*44*
17	.23247	.17079	.23663	.17244	.24077	.17409	.24489	.17575	.24898	.17741	*43*
18	.23254	.17082	.23670	.17246	.24084	.17412	.24495	.17577	.24905	.17744	*42*
19	.23261	.17085	.23677	.17249	.24091	.17414	.24502	.17580	.24911	.17746	*41*
+ 5′	9.23268	.17087	9.23684	.17252	9.24098	.17417	9.24509	.17583	9.24918	.17749	*40*
21	.23275	.17090	.23691	.17255	.24105	.17420	.24516	.17586	.24925	.17752	*39*
22	.23282	.17093	.23698	.17257	.24111	.17423	.24523	.17588	.24932	.17755	*38*
23	.23289	.17096	.23705	.17260	.24118	.17425	.24530	.17591	.24939	.17758	*37*
+ 6′	9.23295	.17099	9.23712	.17263	9.24125	.17428	9.24536	.17594	9.24945	.17760	*36*
25	.23302	.17101	.23718	.17266	.24132	.17431	.24543	.17597	.24952	.17763	*35*
26	.23309	.17104	.23725	.17268	.24139	.17434	.24550	.17600	.24959	.17766	*34*
27	.23316	.17107	.23732	.17271	.24146	.17436	.24557	.17602	.24966	.17769	*33*
+ 7′	9.23323	.17110	9.23739	.17274	9.24153	.17439	9.24564	.17605	9.24973	.17772	*32*
29	.23330	.17112	.23746	.17277	.24160	.17442	.24571	.17608	.24979	.17774	*31*
30	.23337	.17115	.23753	.17279	.24166	.17445	.24577	.17611	.24986	.17777	*30*
31	.23344	.17117	.23760	.17282	.24173	.17447	.24584	.17613	.24993	.17780	*29*
+ 8′	9.23351	.17120	9.23767	.17285	9.24180	.17450	9.24591	.17616	9.25000	.17783	*28*
33	.23358	.17123	.23774	.17288	.24187	.17453	.24598	.17619	.25007	.17786	*27*
34	.23365	.17126	.23781	.17290	.24194	.17456	.24605	.17622	.25013	.17788	*26*
35	.23372	.17128	.23788	.17293	.24201	.17458	.24612	.17624	.25020	.17791	*25*
+ 9′	9.23379	.17131	9.23794	.17296	9.24208	.17461	9.24618	.17627	9.25027	.17794	*24*
37	.23386	.17134	.23801	.17299	.24215	.17464	.24625	.17630	.25034	.17797	*23*
38	.23393	.17137	.23808	.17301	.24221	.17467	.24632	.17633	.25040	.17799	*22*
39	.23400	.17139	.23815	.17304	.24228	.17470	.24639	.17636	.25047	.17802	*21*
+ 10′	9.23407	.17142	9.23822	.17307	9.24235	.17472	9.24646	.17638	9.25054	.17805	*20*
41	.23414	.17145	.23829	.17310	.24242	.17475	.24653	.17641	.25061	.17808	*19*
42	.23421	.17148	.23836	.17313	.24249	.17478	.24659	.17644	.25068	.17811	*18*
43	.23427	.17150	.23843	.17315	.24256	.17481	.24666	.17647	.25074	.17813	*17*
+ 11′	9.23434	.17153	9.23850	.17318	9.24263	.17483	9.24673	.17649	9.25081	.17816	*16*
45	.23441	.17156	.23857	.17321	.24269	.17486	.24680	.17652	.25088	.17819	*15*
46	.23448	.17159	.23863	.17323	.24276	.17489	.24687	.17655	.25095	.17822	*14*
47	.23455	.17161	.23870	.17326	.24283	.17492	.24694	.17658	.25102	.17824	*13*
+ 12′	9.23462	.17164	9.23877	.17329	9.24290	.17494	9.24700	.17661	9.25108	.17827	*12*
49	.23469	.17167	.23884	.17332	.24297	.17497	.24707	.17663	.25115	.17830	*11*
50	.23476	.17170	.23891	.17335	.24304	.17500	.24714	.17666	.25122	.17833	*10*
51	.23483	.17172	.23898	.17337	.24311	.17503	.24721	.17669	.25129	.17836	*9*
+ 13′	9.23490	.17175	9.23905	.17340	9.24317	.17505	9.24728	.17672	9.25135	.17838	*8*
53	.23497	.17178	.23912	.17343	.24324	.17508	.24734	.17674	.25142	.17841	*7*
54	.23504	.17181	.23919	.17346	.24331	.17511	.24741	.17677	.25149	.17844	*6*
55	.23511	.17183	.23926	.17348	.24338	.17514	.24748	.17680	.25156	.17847	*5*
+ 14′	9.23518	.17186	9.23932	.17351	9.24345	.17517	9.24755	.17683	9.25163	.17850	*4*
57	.23525	.17189	.23939	.17354	.24352	.17519	.24762	.17686	.25169	.17852	*3*
58	.23532	.17192	.23946	.17357	.24359	.17522	.24768	.17688	.25176	.17855	*2*
59	.23538	.17194	.23953	.17359	.24365	.17525	.24775	.17691	.25183	.17858	*1*
+ 15′	9.23545	.17197	9.23960	.17362	9.24372	.17528	9.24782	.17694	9.25190	.17861	*0*
	20h 44m		*20h 43m*		*20h 42m*		*20h 41m*		*20h 40m*		

TABLE 45.

Haversines.

s	$3^h\ 20^m$ 50° 0′		$3^h\ 21^m$ 50° 15′		$3^h\ 22^m$ 50° 30′		$3^h\ 2$
	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. H
0	9.25190	.17861	9.25595	.18028	9.25998	.18196	9.2639
1	.25196	.17863	.25602	.18031	.26005	.18199	.2640
2	.25203	.17866	.25608	.18034	.26011	.18202	.2641
3	.25210	.17869	.25615	.18036	.26018	.18205	.2641
+ 1′	9.25217	.17872	9.25622	.18039	9.26025	.18207	9.2642
5	.25224	.17875	.25629	.18042	.26031	.18210	.2643
6	.25230	.17877	.25635	.18045	.26038	.18213	.2643
7	.25237	.17880	.25642	.18048	.26045	.18216	.2644
+ 2′	9.25244	.17883	9.25649	.18050	9.26051	.18219	9.2645
9	.25251	.17886	.25655	.18053	.26058	.18221	.2645
10	.25257	.17888	.25662	.18056	.26065	.18224	.2646
11	.25264	.17891	.25669	.18059	.26071	.18227	.2647
+ 3′	9.25271	.17894	9.25676	.18062	9.26078	.18230	9.2647
13	.25278	.17897	.25682	.18064	.26085	.18233	.2648
14	.25284	.17900	.25689	.18067	.26091	.18235	.2649
15	.25291	.17902	.25696	.18070	.26098	.18238	.2649
+ 4′	9.25298	.17905	9.25703	.18073	9.26105	.18241	9.2650
17	.25305	.17908	.25709	.18076	.26112	.18244	.2651
18	.25311	.17911	.25716	.18078	.26118	.18247	.2651
19	.25318	.17914	.25723	.18081	.26125	.18249	.2652
+ 5′	9.25325	.17916	9.25729	.18084	9.26132	.18252	9.2653
21	.25332	.17919	.25736	.18087	.26138	.18255	.2653
22	.25339	.17922	.25743	.18090	.26145	.18258	.2654
23	.25345	.17925	.25750	.18092	.26152	.18261	.2655
+ 6′	9.25352	.17928	9.25756	.18095	9.26158	.18263	9.2655
25	.25359	.17930	.25763	.18098	.26165	.18266	.2656
26	.25366	.17933	.25770	.18101	.26172	.18269	.2657
27	.25372	.17936	.25776	.18104	.26178	.18272	.2657
+ 7′	9.25379	.17939	9.25783	.18106	9.26185	.18275	9.2658
29	.25386	.17941	.25790	.18109	.26192	.18277	.2659
30	.25393	.17944	.25797	.18112	.26198	.18280	.2659
31	.25399	.17947	.25803	.18115	.26205	.18283	.2660
+ 8′	9.25406	.17950	9.25810	.18118	9.26212	.18286	9.2661
33	.25413	.17953	.25817	.18120	.26218	.18289	.2661
34	.25420	.17955	.25823	.18123	.26225	.18292	.2662
35	.25426	.17958	.25830	.18126	.26232	.18294	.2663
+ 9′	9.25433	.17961	9.25837	.18129	9.26238	.18297	9.2663
37	.25440	.17964	.25844	.18132	.26245	.18300	.2664
38	.25447	.17967	.25850	.18134	.26252	.18303	.2665
39	.25453	.17969	.25857	.18137	.26259	.18306	.2665
+ 10′	9.25460	.17972	9.25864	.18140	9.26265	.18308	9.2666
41	.25467	.17975	.25870	.18143	.26272	.18311	.2667
42	.25474	.17978	.25877	.18146	.26279	.18314	.2667
43	.25480	.17981	.25884	.18148	.26285	.18317	.2668
+ 11′	9.25487	.17983	9.25891	.18151	9.26292	.18320	9.2669
45	.25494	.17986	.25897	.18154	.26299	.18323	.2669
46	.25500	.17989	.25904	.18157	.26305	.18325	.2670
47	.25507	.17992	.25911	.18160	.26312	.18328	.2671
+ 12′	9.25514	.17995	9.25917	.18162	9.26319	.18331	9.2671
49	.25521	.17997	.25924	.18165	.26325	.18334	.2672
50	.25528	.18000	.25931	.18168	.26332	.18337	.2673
51	.25534	.18003	.25938	.18171	.26339	.18339	.2673
+ 13′	9.25541	.18006	9.25944	.18174	9.26345	.18342	9.2674
53	.25548	.18008	.25951	.18176	.26352	.18345	.2675
54	.25544	.18011	.25958	.18179	.26359	.18348	.2675
55	.25561	.18014	.25964	.18182	.26365	.18351	.2676
+ 14′	9.25568	.18017	9.25971	.18185	9.26372	.18353	9.2677
57	.25575	.18020	.25978	.18188	.26378	.18356	.2677
58	.25581	.18022	.25984	.18190	.26385	.18359	.2678
59	.25588	.18025	.25991	.18193	.26392	.18362	.2679
+ 15′	9.25595	.18028	9.25998	.18196	9.26398	.18365	9.2679
	$20^h\ 39^m$		$20^h\ 38^m$		$20^h\ 37^m$		2

TABLE 45.

Haversines.

s	3h 25m 51° 15′		3h 26m 51° 30′		3h 27m 51° 45′		3h 28m 52° 0′		3h 29m 52° 15′		s
	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	
0	9.27193	.18704	9.27587	.18874	9.27979	.19045	9.28368	.19217	9.28756	.19389	60
1	.27200	.18707	.27594	.18877	.27985	.19048	.28375	.19220	.28762	.19392	59
2	.27206	.18710	.27600	.18880	.27992	.19051	.28381	.19223	.28769	.19395	58
3	.27213	.18712	.27607	.18883	.27998	.19054	.28388	.19226	.28775	.19398	57
+ 1′	9.27219	.18715	9.27613	.18886	9.28005	.19057	9.28394	.19228	9.28782	.19401	56
5	.27226	.18718	.27620	.18888	.28011	.19060	.28401	.19231	.28788	.19404	55
6	.27233	.18721	.27626	.18891	.28018	.19062	.28407	.19234	.28794	.19406	54
7	.27239	.18724	.27633	.18894	.28024	.19065	.28414	.19237	.28801	.19409	53
+ 2′	9.27246	.18727	9.27639	.18897	9.28031	.19068	9.28420	.19240	9.28807	.19412	52
9	.27252	.18729	.27646	.18900	.28037	.19071	.28427	.19243	.28814	.19415	51
10	.27259	.18732	.27652	.18903	.28044	.19074	.28433	.19246	.28820	.19418	50
11	.27265	.18735	.27659	.18906	.28050	.19077	.28440	.19248	.28827	.19421	49
+ 3′	9.27272	.18738	9.27666	.18908	9.28057	.19080	9.28446	.19251	9.28833	.19424	48
13	.27279	.18741	.27672	.18912	.28063	.19083	.28453	.19254	.28840	.19427	47
14	.27285	.18744	.27679	.18914	.28070	.19085	.28459	.19257	.28846	.19429	46
15	.27292	.18746	.27685	.18917	.28076	.19088	.28465	.19260	.28852	.19432	45
+ 4′	9.27298	.18749	9.27692	.18920	9.28083	.19091	9.28472	.19263	9.28859	.19435	44
17	.27305	.18752	.27698	.18923	.28089	.19094	.28478	.19266	.28865	.19438	43
18	.27311	.18755	.27705	.18926	.28096	.19097	.28485	.19269	.28872	.19441	42
19	.27318	.18758	.27711	.18928	.28102	.19100	.28491	.19271	.28878	.19444	41
+ 5′	9.27325	.18761	9.27718	.18931	9.28109	.19102	9.28498	.19274	9.28885	.19447	40
21	.27331	.18763	.27724	.18934	.28115	.19105	.28504	.19277	.28891	.19450	39
22	.27338	.18766	.27731	.18937	.28122	.19108	.28511	.19280	.28897	.19452	38
23	.27344	.18769	.27737	.18940	.28128	.19111	.28517	.19283	.28904	.19455	37
+ 6′	9.27351	.18772	9.27744	.18943	9.28135	.19114	9.28524	.19286	9.28910	.19458	36
25	.27357	.18775	.27751	.18945	.28141	.19117	.28530	.19289	.28917	.19461	35
26	.27364	.18778	.27757	.18948	.28148	.19120	.28537	.19291	.28923	.19464	34
27	.27371	.18780	.27764	.18951	.28154	.19122	.28543	.19294	.28930	.19467	33
+ 7′	9.27377	.18783	9.27770	.18954	9.28161	.19125	9.28549	.19297	9.28936	.19470	32
29	.27384	.18786	.27777	.18957	.28167	.19128	.28556	.19300	.28942	.19473	31
30	.27390	.18789	.27783	.18960	.28174	.19131	.28562	.19303	.28949	.19475	30
31	.27397	.18792	.27790	.18963	.28180	.19134	.28569	.19306	.28955	.19478	29
+ 8′	9.27403	.18795	9.27796	.18965	9.28187	.19137	9.28575	.19309	9.28962	.19481	28
33	.27410	.18797	.27803	.18968	.28193	.19140	.28582	.19311	.28968	.19484	27
34	.27417	.18800	.27809	.18971	.28200	.19142	.28588	.19314	.28974	.19487	26
35	.27423	.18803	.27816	.18974	.28206	.19145	.28595	.19317	.28981	.19490	25
+ 9′	9.27430	.18806	9.27822	.18977	9.28213	.19148	9.28601	.19320	9.28987	.19493	24
37	.27436	.18809	.27829	.18980	.28219	.19151	.28608	.19323	.28994	.19496	23
38	.27443	.18812	.27835	.18983	.28226	.19154	.28614	.19326	.29000	.19499	22
39	.27449	.18815	.27842	.18985	.28232	.19157	.28620	.19329	.29007	.19501	21
+ 10′	9.27456	.18817	9.27848	.18988	9.28239	.19160	9.28627	.19332	9.29013	.19504	20
41	.27463	.18820	.27855	.18991	.28245	.19163	.28633	.19335	.29019	.19507	19
42	.27469	.18823	.27861	.18994	.28252	.19165	.28640	.19337	.29026	.19510	18
43	.27476	.18826	.27868	.18997	.28258	.19168	.28646	.19340	.29032	.19513	17
+ 11′	9.27482	.18829	9.27875	.19000	9.28265	.19171	9.28653	.19343	9.29039	.19516	16
45	.27489	.18832	.27881	.19002	.28271	.19174	.28659	.19346	.29045	.19519	15
46	.27495	.18834	.27888	.19005	.28278	.19177	.28666	.19349	.29051	.19522	14
47	.27502	.18837	.27894	.19008	.28284	.19180	.28672	.19352	.29058	.19524	13
+ 12′	9.27508	.18840	9.27901	.19011	9.28291	.19183	9.28679	.19355	9.29064	.19527	12
49	.27515	.18843	.27907	.19014	.28297	.19185	.28685	.19358	.29071	.19530	11
50	.27522	.18846	.27914	.19017	.28304	.19188	.28691	.19360	.29078	.19533	10
51	.27528	.18849	.27920	.19020	.28310	.19191	.28698	.19363	.29084	.19536	9
+ 13′	9.27535	.18852	9.27927	.19022	9.28317	.19194	9.28704	.19366	9.29090	.19539	8
53	.27541	.18854	.27933	.19025	.28323	.19197	.28711	.19369	.29096	.19542	7
54	.27548	.18857	.27940	.19028	.28330	.19200	.28717	.19372	.29103	.19545	6
55	.27554	.18860	.27946	.19031	.28336	.19203	.28724	.19375	.29109	.19548	5
+ 14′	9.27561	.18863	9.27953	.19034	9.28342	.19205	9.28730	.19378	9.29116	.19550	4
57	.27567	.18866	.27959	.19037	.28349	.19208	.28737	.19381	.29122	.19553	3
58	.27574	.18869	.27966	.19040	.28355	.19211	.28743	.19383	.29128	.19556	2
59	.27580	.18871	.27972	.19042	.28362	.19214	.28749	.19386	.29135	.19559	1
+ 15′	9.27587	.18874	9.27979	.19045	9.28368	.19217	9.28756	.19389	9.29141	.19562	0
	20h 34m		20h 33m		20h 32m		20h 31m		20h 30m		

TABLE 45.

Haversines.

	$3^h\ 35^m$ 53° 45′		$3^h\ 36^m$ 54° 0′		$3^h\ 37^m$ 54° 15′		$3^h\ 38^m$ 54° 30′		$3^h\ 39^m$ 54° 45′		
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	s
0	9.31036	.20435	9.31409	.20611	9.31780	.20788	9.32149	.20965	9.32516	.21143	60
1	.31043	.20437	.31416	.20614	.31786	.20790	.32155	.20968	.32522	.21146	59
2	.31049	.20440	.31422	.20617	.31793	.20793	.32161	.20971	.32528	.21149	58
3	.31055	.20443	.31428	.20620	.31799	.20796	.32168	.20974	.32534	.21152	57
+ 1′	9.31061	.20446	9.31434	.20623	9.31805	.20799	9.32174	.20977	9.32541	.21155	56
5	.31068	.20449	.31440	.20626	.31811	.20802	.32180	.20980	.32547	.21158	55
6	.31074	.20452	.31447	.20629	.31817	.20805	.32186	.20983	.32553	.21161	54
7	.31080	.20455	.31453	.20631	.31823	.20808	.32192	.20986	.32559	.21164	53
+ 2′	9.31086	.20458	9.31459	.20634	9.31830	.20811	9.32198	.20988	9.32565	.21167	52
9	.31093	.20461	.31465	.20637	.31836	.20814	.32204	.20991	.32571	.21169	51
10	.31099	.20464	.31471	.20640	.31842	.20817	.32210	.20994	.32577	.21172	50
11	.31105	.20467	.31478	.20643	.31848	.20820	.32217	.20997	.32583	.21175	49
+ 3′	9.31111	.20470	9.31484	.20646	9.31854	.20823	9.32223	.21000	9.32589	.21178	48
13	.31117	.20473	.31490	.20649	.31860	.20826	.32229	.21003	.32595	.21181	47
14	.31124	.20476	.31496	.20652	.31867	.20829	.32235	.21006	.32601	.21184	46
15	.31130	.20479	.31502	.20655	.31873	.20832	.32241	.21009	.32608	.21187	45
+ 4′	9.31136	.20481	9.31508	.20658	9.31879	.20835	9.32247	.21012	9.32614	.21190	44
17	.31142	.20484	.31515	.20661	.31885	.20838	.32253	.21015	.32620	.21193	43
18	.31149	.20487	.31521	.20664	.31891	.20841	.32259	.21018	.32626	.21196	42
19	.31155	.20490	.31527	.20667	.31897	.20844	.32266	.21021	.32632	.21199	41
+ 5′	9.31161	.20493	9.31533	.20670	9.31903	.20847	9.32272	.21024	9.32638	.21202	40
21	.31167	.20496	.31539	.20673	.31910	.20850	.32278	.21027	.32644	.21205	39
22	.31173	.20499	.31546	.20675	.31916	.20852	.32284	.21030	.32650	.21208	38
23	.31180	.20502	.31552	.20678	.31922	.20855	.32290	.21033	.32656	.21211	37
+ 6′	9.31186	.20505	9.31558	.20681	9.31928	.20858	9.32296	.21036	9.32662	.21214	36
25	.31192	.20508	.31564	.20684	.31934	.20861	.32302	.21039	.32668	.21217	35
26	.31198	.20511	.31570	.20687	.31940	.20864	.32308	.21042	.32675	.21220	34
27	.31205	.20514	.31577	.20690	.31947	.20867	.32315	.21045	.32681	.21223	33
+ 7′	9.31211	.20517	9.31583	.20693	9.31953	.20870	9.32321	.21048	9.32687	.21226	32
29	.31217	.20520	.31589	.20696	.31959	.20873	.32327	.21051	.32693	.21229	31
30	.31223	.20523	.31595	.20699	.31965	.20876	.32333	.21054	.32699	.21232	30
31	.31229	.20525	.31601	.20702	.31971	.20879	.32339	.21057	.32705	.21235	29
+ 8′	9.31236	.20528	9.31607	.20705	9.31977	.20882	9.32345	.21060	9.32711	.21238	28
33	.31242	.20531	.31614	.20708	.31983	.20885	.32351	.21063	.32717	.21241	27
34	.31248	.20534	.31620	.20711	.31990	.20888	.32357	.21066	.32723	.21244	26
35	.31254	.20537	.31626	.20714	.31996	.20891	.32363	.21069	.32729	.21247	25
+ 9′	9.31260	.20540	9.31632	.20717	9.32002	.20894	9.32370	.21072	9.32735	.21250	24
37	.31267	.20543	.31638	.20720	.32008	.20897	.32376	.21074	.32741	.21253	23
38	.31273	.20546	.31644	.20723	.32014	.20900	.32382	.21077	.32748	.21256	22
39	.31279	.20549	.31651	.20726	.32020	.20903	.32388	.21080	.32754	.21259	21
+ 10′	9.31285	.20552	9.31657	.20729	9.32026	.20906	9.32394	.21083	9.32760	.21262	20
41	.31291	.20555	.31663	.20731	.32033	.20909	.32400	.21086	.32766	.21265	19
42	.31298	.20558	.31669	.20734	.32039	.20912	.32406	.21089	.32772	.21268	18
43	.31304	.20561	.31675	.20737	.32045	.20915	.32412	.21092	.32778	.21271	17
+ 11′	9.31310	.20564	9.31682	.20740	9.32051	.20918	9.32418	.21095	9.32784	.21274	16
45	.31316	.20567	.31688	.20743	.32057	.20920	.32425	.21098	.32790	.21277	15
46	.31323	.20570	.31694	.20746	.32063	.20923	.32431	.21101	.32796	.21280	14
47	.31329	.20573	.31700	.20749	.32069	.20926	.32437	.21104	.32802	.21283	13
+ 12′	9.31335	.20575	9.31706	.20752	9.32076	.20929	9.32443	.21107	9.32808	.21285	12
49	.31341	.20578	.31712	.20755	.32082	.20932	.32449	.21110	.32814	.21288	11
50	.31347	.20581	.31719	.20758	.32088	.20935	.32455	.21113	.32820	.21291	10
51	.31354	.20584	.31725	.20761	.32094	.20938	.32461	.21116	.32827	.21294	9
+ 13′	9.31360	.20587	9.31731	.20764	9.32100	.20941	9.32467	.21119	9.32833	.21297	8
53	.31366	.20590	.31737	.20767	.32106	.20944	.32473	.21122	.32839	.21300	7
54	.31372	.20593	.31743	.20770	.32112	.20947	.32480	.21125	.32845	.21303	6
55	.31378	.20596	.31749	.20773	.32119	.20950	.32486	.21128	.32851	.21306	5
+ 14′	9.31385	.20599	9.31756	.20776	9.32125	.20953	9.32492	.21131	9.32857	.21309	4
57	.31391	.20602	.31762	.20779	.32131	.20956	.32498	.21134	.32863	.21312	3
58	.31397	.20605	.31768	.20782	.32137	.20959	.32504	.21137	.32869	.21315	2
59	.31403	.20608	.31774	.20785	.32143	.20962	.32510	.21140	.32875	.21318	1
+ 15′	9.31409	.20611	9.31780	.20788	9.32149	.20965	9.32516	.21143	9.32881	.21321	0
	$20^h\ 24^m$		$20^h\ 23^m$		$20^h\ 22^m$		$20^h\ 21^m$		$20^h\ 20^m$		

TABLE 45.

Haversines.

	$3^h 40^m$ 55° 0′		$3^h 41^m$ 55° 15′		$3^h 42^m$ 55° 30′		$3^h 43^m$ 55° 45′		$3^h 44^m$ 56° 0′		
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	s
0	9.32881	.21321	9.33244	.21500	9.33605	.21680	9.33965	.21860	9.34322	.22040	60
1	.32887	.21324	.33250	.21503	.33611	.21683	.33971	.21863	.34328	.22043	59
2	.32893	.21327	.33256	.21506	.33617	.21686	.33976	.21866	.34334	.22046	58
3	.32899	.21330	.33262	.21509	.33623	.21689	.33982	.21869	.34340	.22049	57
+ 1′	9.32905	.21333	9.33268	.21512	9.33629	.21692	9.33988	.21872	9.34346	.22052	56
5	.32911	.21336	.33274	.21515	.33635	.21695	.33994	.21875	.34352	.22055	55
6	.32918	.21339	.33280	.21518	.33641	.21698	.34000	.21878	.34358	.22058	54
7	.32924	.21342	.33286	.21521	.33647	.21701	.34006	.21881	.34363	.22061	53
+ 2′	9.32930	.21345	9.33292	.21524	9.33653	.21704	9.34012	.21884	9.34369	.22064	52
9	.32936	.21348	.33298	.21527	.33659	.21707	.34018	.21887	.34375	.22067	51
10	.32942	.21351	.33305	.21530	.33665	.21710	.34024	.21890	.34381	.22071	50
11	.32948	.21354	.33311	.21533	.33671	.21713	.34030	.21893	.34387	.22074	49
+ 3′	9.32954	.21357	9.33317	.21536	9.33677	.21716	9.34036	.21896	9.34393	.22077	48
13	.32960	.21360	.33323	.21539	.33683	.21719	.34042	.21899	.34399	.22080	47
14	.32966	.21363	.33329	.21542	.33689	.21722	.34048	.21902	.34405	.22083	46
15	.32972	.21366	.33335	.21545	.33695	.21725	.34054	.21905	.34411	.22086	45
+ 4′	9.32978	.21369	9.33341	.21548	9.33701	.21728	9.34060	.21908	9.34417	.22089	44
17	.32984	.21372	.33347	.21551	.33707	.21731	.34066	.21911	.34423	.22092	43
18	.32990	.21375	.33353	.21554	.33713	.21734	.34072	.21914	.34429	.22095	42
19	.32996	.21378	.33359	.21557	.33719	.21737	.34078	.21917	.34435	.22098	41
+ 5′	9.33002	.21381	9.33365	.21560	9.33725	.21740	9.34084	.21920	9.34441	.22101	40
21	.33008	.21384	.33371	.21563	.33731	.21743	.34090	.21923	.34446	.22104	39
22	.33014	.21387	.33377	.21566	.33737	.21746	.34096	.21926	.34452	.22107	38
23	.33021	.21390	.33383	.21569	.33743	.21749	.34102	.21929	.34458	.22110	37
+ 6′	9.33027	.21393	9.33389	.21572	9.33749	.21752	9.34108	.21932	9.34464	.22113	36
25	.33033	.21396	.33395	.21575	.33755	.21755	.34114	.21935	.34470	.22116	35
26	.33039	.21399	.33401	.21578	.33761	.21758	.34120	.21938	.34476	.22119	34
27	.33045	.21402	.33407	.21581	.33767	.21761	.34126	.21941	.34482	.22122	33
+ 7′	9.33051	.21405	9.33413	.21584	9.33773	.21764	9.34132	.21944	9.34488	.22125	32
29	.33057	.21408	.33419	.21587	.33779	.21767	.34137	.21947	.34494	.22128	31
30	.33063	.21411	.33425	.21590	.33785	.21770	.34143	.21950	.34500	.22131	30
31	.33069	.21414	.33431	.21593	.33791	.21773	.34149	.21953	.34506	.22134	29
+ 8′	9.33075	.21417	9.33437	.21596	9.33797	.21776	9.34155	.21956	9.34512	.22137	28
33	.33081	.21420	.33443	.21599	.33803	.21779	.34161	.21959	.34518	.22140	27
34	.33087	.21423	.33449	.21602	.33809	.21782	.34167	.21962	.34524	.22143	26
35	.33093	.21426	.33455	.21605	.33815	.21785	.34173	.21965	.34529	.22146	25
+ 9′	9.33099	.21429	9.33461	.21608	9.33821	.21788	9.34179	.21968	9.34535	.22149	24
37	.33105	.21431	.33467	.21611	.33827	.21791	.34185	.21971	.34541	.22152	23
38	.33111	.21434	.33473	.21614	.33833	.21794	.34191	.21974	.34547	.22155	22
39	.33117	.21437	.33479	.21617	.33839	.21797	.34197	.21977	.34553	.22158	21
+ 10′	9.33123	.21440	9.33485	.21620	9.33845	.21800	9.34203	.21980	9.34559	.22161	20
41	.33129	.21443	.33491	.21623	.33851	.21803	.34209	.21983	.34565	.22164	19
42	.33135	.21446	.33497	.21626	.33857	.21806	.34215	.21986	.34571	.22167	18
43	.33142	.21449	.33503	.21629	.33863	.21809	.34221	.21989	.34577	.22170	17
+ 11′	9.33148	.21452	9.33509	.21632	9.33869	.21812	9.34227	.21992	9.34583	.22173	16
45	.33154	.21455	.33515	.21635	.33875	.21815	.34233	.21995	.34589	.22176	15
46	.33160	.21458	.33521	.21638	.33881	.21818	.34239	.21998	.34595	.22179	14
47	.33166	.21461	.33527	.21641	.33887	.21821	.34245	.22001	.34600	.22182	13
+ 12′	9.33172	.21464	9.33533	.21644	9.33893	.21824	9.34251	.22004	9.34606	.22185	12
49	.33178	.21467	.33539	.21647	.33899	.21827	.34256	.22007	.34612	.22188	11
50	.33184	.21470	.33545	.21650	.33905	.21830	.34262	.22010	.34618	.22191	10
51	.33190	.21473	.33551	.21653	.33911	.21833	.34268	.22013	.34624	.22194	9
+ 13′	9.33196	.21476	9.33557	.21656	9.33917	.21836	9.34274	.22016	9.34630	.22197	8
53	.33202	.21479	.33563	.21659	.33923	.21839	.34280	.22019	.34636	.22200	7
54	.33208	.21482	.33569	.21662	.33929	.21842	.34286	.22022	.34642	.22203	6
55	.33214	.21485	.33575	.21665	.33935	.21845	.34292	.22025	.34648	.22206	5
+ 14′	9.33220	.21488	9.33581	.21668	9.33941	.21848	9.34298	.22028	9.34654	.22209	4
57	.33226	.21491	.33587	.21671	.33947	.21851	.34304	.22031	.34660	.22212	3
58	.33232	.21494	.33593	.21674	.33953	.21854	34310	.22034	.34666	.22215	2
59	.33238	.21497	.33599	.21677	.33959	.21857	.34316	.22037	.34671	.22218	1
+ 15′	9.33244	.21500	9.33605	.21680	9.33965	.21860	9.34322	.22040	9.34677	.22221	0
	$20^h 19^m$		$20^h 18^m$		$20^h 17^m$		$20^h 16^m$		$20^h 15^m$		

TABLE 45.

Haversines.

s	$3^h 45^m$ 56° 15′		$3^h 46^m$ 56° 30′		$3^h 47^m$ 56° 45′		$3^h 48^m$ 57° 0′		$3^h 49^m$ 57° 15′		s
	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat .Hav.	
0	9.34677	.22221	9.35031	.22403	9.35383	.22585	9.35733	.22768	9.36081	.22951	60
1	.34683	.22225	.35037	.22406	.35389	.22588	.35738	.22771	.36086	.22954	59
2	.34689	.22228	.35043	.22409	.35394	.22591	.35744	.22774	.36092	.22957	58
3	.34695	.22231	.35049	.22412	.35400	.22594	.35750	.22777	.36098	.22960	57
+ 1′	9.34701	.22234	9.35054	.22415	9.35406	.22598	9.35756	.22780	9.36104	.22964	56
5	.34707	.22237	.35060	.22418	.35412	.22601	.35762	.22783	.36110	.22967	55
6	.34713	.22240	.35066	.22421	.35418	.22604	.35767	.22786	.36115	.22970	54
7	.34719	.22243	.35072	.22424	.35424	.22607	.35773	.22789	.36121	.22973	53
+ 2′	9.34725	.22246	9.35078	.22427	9.35429	.22610	9.35779	.22792	9.36127	.22976	52
9	.34730	.22249	.35084	.22430	.35435	.22613	.35785	.22795	.36133	.22979	51
10	.34736	.22252	.35090	.22433	.35441	.22616	.35791	.22799	.36139	.22982	50
11	.34742	.22255	.35096	.22437	.35447	.22619	.35797	.22802	.36144	.22985	49
+ 3′	9.34748	.22258	9.35101	.22440	9.35453	.22622	9.35802	.22805	9.36150	.22988	48
13	.34754	.22261	.35107	.22443	.35459	.22625	.35808	.22808	.36156	.22991	47
14	.34760	.22264	.35113	.22446	.35464	.22628	.35814	.22811	.36162	.22994	46
15	.34766	.22267	.35119	.22449	.35470	.22631	.35820	.22814	.36167	.22997	45
+ 4′	9.34772	.22270	9.35125	.22452	9.35476	.22634	9.35826	.22817	9.36173	.23000	44
17	.34778	.22273	.35131	.22455	.35482	.22637	.35831	.22820	.36179	.23003	43
18	.34784	.22276	.35137	.22458	.35488	.22640	.35837	.22823	.36185	.23006	42
19	.34789	.22279	.35143	.22461	.35494	.22643	.35843	.22826	.36191	.23009	41
+ 5′	9.34795	.22282	9.35148	.22464	9.35500	.22646	9.35849	.22829	9.36196	.23012	40
21	.34801	.22285	.35154	.22467	.35505	.22649	.35855	.22832	.36202	.23016	39
22	.34807	.22288	.35160	.22470	.35511	.22652	.35860	.22835	.36208	.23019	38
23	.34813	.22291	.35166	.22473	.35517	.22655	.35866	.22838	.36214	.23022	37
+ 6′	9.34819	.22294	9.35172	.22476	9.35523	.22658	9.35872	.22841	9.36219	.23025	36
25	.34825	.22297	.35178	.22479	.35529	.22661	.35878	.22844	.36225	.23028	35
26	.34831	.22300	.35184	.22482	.35535	.22664	.35884	.22847	.36231	.23031	34
27	.34837	.22303	.35189	.22485	.35540	.22667	.35889	.22850	.36237	.23034	33
+ 7′	9.34843	.22306	9.35195	.22488	9.35546	.22671	9.35895	.22853	9.36243	.23037	32
29	.34848	.22309	.35201	.22491	.35552	.22674	.35901	.22857	.36248	.23040	31
30	.34854	.22312	.35207	.22494	.35558	.22677	.35907	.22860	.36254	.23043	30
31	.34860	.22315	.35213	.22497	.35564	.22680	.35913	.22863	.36260	.23046	29
+ 8′	9.34866	.22318	9.35219	.22500	9.35570	.22683	9.35918	.22866	9.36266	.23049	28
33	.34872	.22321	.35225	.22503	.35575	.22686	.35924	.22869	.36271	.23052	27
34	.34878	.22324	.35230	.22506	.35581	.22689	.35930	.22872	.36277	.23055	26
35	.34884	.22327	.35236	.22509	.35587	.22692	.35936	.22875	.36283	.23058	25
+ 9′	9.34890	.22330	9.35242	.22512	9.35593	.22695	9.35942	.22878	9.36289	.23061	24
37	.34896	.22333	.35248	.22515	.35599	.22698	.35947	.22881	.36294	.23065	23
38	.34901	.22336	.35254	.22518	.35604	.22701	.35953	.22884	.36300	.23068	22
39	.34907	.22340	.35260	.22522	.35610	.22704	.35959	.22887	.36306	.23071	21
+ 10′	9.34913	.22343	9.35266	.22525	9.35616	.22707	9.35965	.22890	9.36312	.23074	20
41	.34919	.22346	.35271	.22528	.35622	.22710	.35971	.22893	.36318	.23077	19
42	.34925	.22349	.35277	.22531	.35628	.22713	.35976	.22896	.36323	.23080	18
43	.34931	.22352	.35283	.22534	.35634	.22716	.35982	.22899	.36329	.23083	17
+ 11′	9.34937	.22355	9.35289	.22537	9.35639	.22719	9.35988	.22902	9.36335	.23086	16
45	.34943	.22358	.35295	.22540	.35645	.22722	.35994	.22905	.36341	.23089	15
46	.34949	.22361	.35301	.22543	.35651	.22725	.36000	.22908	.36346	.23092	14
47	.34954	.22364	.35307	.22546	.35657	.22728	.36005	.22912	.36352	.23095	13
+ 12′	9.34960	.22367	9.35312	.22549	9.35663	.22731	9.36011	.22915	9.36358	.23098	12
49	.34966	.22370	.35318	.22552	.35669	.22735	.36017	.22918	.36364	.23101	11
50	.34972	.22373	.35324	.22555	.35674	.22738	.36023	.22921	.36369	.23104	10
51	.34978	.22376	.35330	.22558	.35680	.22741	.36029	.22924	.36375	.23107	9
+ 13′	9.34984	.22379	9.35336	.22561	9.35686	.22744	9.36034	.22927	9.36381	.23110	8
53	.34990	.22382	.35342	.22564	.35692	.22747	.36040	.22930	.36387	.23114	7
54	.34996	.22385	.35348	.22567	.35698	.22750	.36046	.22933	.36392	.23117	6
55	.35002	.22388	.35353	.22570	.35703	.22753	.36052	.22936	.36398	.23120	5
+ 14′	9.35007	.22391	9.35359	.22573	9.35709	.22756	9.36058	.22939	9.36404	.23123	4
57	.35013	.22394	.35365	.22576	.35715	.22759	.36063	.22942	.36410	.23126	3
58	.35019	.22397	.35371	.22579	.35721	.22762	.36069	.22945	.36415	.23129	2
59	.35025	.22400	.35377	.22582	.35727	.22765	.36075	.22948	.36421	.23132	1
+ 15′	9.35031	.22403	9.35383	.22585	9.35733	.22768	9.36081	.22951	9.36427	.23135	0
	$20^h 14^m$		$20^h 13^m$		$20^h 12^m$		$20^h 11^m$		$20^h 10^m$		

TABLE 45.

Haversines.

	$3^h\ 50^m$ 57° 30′		$3^h\ 51^m$ 57° 45′		$3^h\ 52^m$ 58° 0′		$3^h\ 53^m$
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.
0	9.36427	.23135	9.36772	.23319	9.37114	.23504	9.37455
1	.36433	.23138	.36777	.23322	.37120	.23507	.37461
2	.36439	.23141	.36783	.23325	.37126	.23510	.37467
3	.36444	.23144	.36789	.23329	.37131	.23513	.37472
+ 1′	9.36450	.23147	9.36794	.23332	9.37137	.23516	9.37478
5	.36456	.23150	.36800	.23335	.37143	.23519	.37484
6	.36462	.23153	.36806	.23338	.37148	.23523	.37489
7	.36467	.23156	.36812	.23341	.37154	.23526	.37495
+ 2′	9.36473	.23160	9.36817	.23344	9.37160	.23529	9.37501
9	.36479	.23163	.36823	.23347	.37166	.23532	.37506
10	.36485	.23166	.36829	.23350	.37171	.23535	.37512
11	.36490	.23169	.36834	.23353	.37177	.23538	.37518
+ 3′	9.36496	.23172	9.36840	.23356	9.37183	.23541	9.37523
13	.36502	.23175	.36846	.23359	.37188	.23544	.37529
14	.36508	.23178	.36852	.23362	.37194	.23547	.37535
15	.36513	.23181	.36857	.23365	.37200	.23550	.37540
+ 4′	9.36519	.23184	9.36863	.23368	9.37205	.23553	9.37546
17	.36525	.23187	.36869	.23372	.37211	.23556	.37552
18	.36531	.23190	.36875	.23375	.37217	.23560	.37557
19	.36536	.23193	.36880	.23378	.37222	.23563	.37563
+ 5′	9.36542	.23196	9.36886	.23381	9.37228	.23566	9.37569
21	.36548	.23199	.36892	.23384	.37234	.23569	.37574
22	.36554	.23203	.36897	.23387	.37239	.23572	.37580
23	.36559	.23206	.36903	.23390	.37245	.23575	.37585
+ 6′	9.36565	.23209	9.36909	.23393	9.37251	.23578	9.37591
25	.36571	.23212	.36915	.23396	.37257	.23581	.37597
26	.36577	.23215	.36920	.23399	.37262	.23584	.37602
27	.36582	.23218	.36926	.23402	.37268	.23587	.37608
+ 7′	9.36588	.23221	9.36932	.23405	9.37274	.23590	9.37614
29	.36594	.23224	.36937	.23409	.37279	.23594	.37619
30	.36599	.23227	.36943	.23412	.37285	.23597	.37625
31	.36605	.23230	.36949	.23415	.37291	.23600	.37631
+ 8′	9.36611	.23233	9.36955	.23418	9.37296	.23603	9.37636
33	.36617	.23236	.36960	.23421	.37302	.23606	.37642
34	.36622	.23239	.36966	.23424	.37308	.23609	.37648
35	.36628	.23242	.36972	.23427	.37313	.23612	.37653
+ 9′	9.36634	.23246	9.36977	.23430	9.37319	.23615	9.37659
37	.36640	.23249	.36983	.23433	.37325	.23618	.37665
38	.36645	.23252	.36989	.23436	.37330	.23621	.37670
39	.36651	.23255	.36995	.23439	.37336	.23624	.37676
+ 10′	9.36657	.23258	9.37000	.23442	9.37342	.23627	9.37682
41	.36663	.23261	.37006	.23445	.37347	.23631	.37687
42	.36668	.23264	.37012	.23449	.37353	.23634	.37693
43	.36674	.23267	.37017	.23452	.37359	.23637	.37699
+ 11′	9.36680	.23270	9.37023	.23455	9.37364	.23640	9.37704
45	.36686	.23273	.37029	.23458	.37370	.23643	.37710
46	.36691	.23276	.37034	.23461	.37376	.23646	.37715
47	.36697	.23279	.37040	.23464	.37382	.23649	.37721
+ 12′	9.36703	.23282	9.37046	.23467	9.37387	.23652	9.37727
49	.36708	.23285	.37052	.23470	.37393	.23655	.37732
50	.36714	.23289	.37057	.23473	.37399	.23658	.37738
51	.36720	.23292	.37063	.23476	.37404	.23661	.37744
+ 13′	9.36726	.23295	9.37069	.23479	9.37410	.23665	9.37749
53	.36731	.23298	.37074	.23482	.37416	.23668	.37755
54	.36737	.23301	.37080	.23486	.37421	.23671	.37761
55	.36743	.23304	.37086	.23489	.37427	.23674	.37766
+ 14′	9.36749	.23307	9.37091	.23492	9.37433	.23677	9.37772
57	.36754	.23310	.37097	.23495	.37438	.23680	.37778
58	.36760	.23313	.37103	.23498	.37444	.23683	.37783
59	.36766	.23316	.37109	.23501	.37450	.23686	.37789
+ 15′	9.36772	.23319	9.37114	.23504	9.37455	.23689	9.37794
	$20^h\ 9^m$		$20^h\ 8^m$		$20^h\ 7^m$		20

61828°—16——47

TABLE 45.

Haversines.

s	*3h 55m 58° 45′*		*3h 56m 59° 0′*		*3h 57m 59° 15′*		*3h 58m 59° 30′*		*3h 59m 59° 45′*		s
	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	
0	9.38132	.24061	9.38468	.24248	9.38802	.24435	9.39134	.24623	9.39465	.24811	*60*
1	.38138	.24064	.38473	.24251	.38807	.24438	.39140	.24626	.39470	.24814	*59*
2	.38143	.24068	.38479	.24254	.38813	.24442	.39145	.24629	.39476	.24818	*58*
3	.38149	.24071	.38485	.24257	.38819	.24445	.39151	.24632	.39481	.24821	*57*
+ 1′	9.38154	.24074	9.38490	.24261	9.38824	.24448	9.39156	.24636	9.39487	.24824	*56*
5	.38160	.24077	.38496	.24264	.38830	.24451	.39162	.24639	.39492	.24827	*55*
6	.38166	.24080	.38501	.24267	.38835	.24454	.39167	.24642	.39498	.24830	*54*
7	.38171	.24083	.38507	.24270	.38841	.24457	.39173	.24645	.39503	.24833	*53*
+ 2′	9.38177	.24086	9.38512	.24273	9.38846	.24460	9.39178	.24648	9.39509	.24836	*52*
9	.38182	.24089	.38518	.24276	.38852	.24463	.39184	.24651	.39514	.24840	*51*
10	.38188	.24092	.38524	.24279	.38857	.24467	.39189	.24654	.39520	.24843	*50*
11	.38194	.24096	.38529	.24282	.38863	.24470	.39195	.24658	.39525	.24846	*49*
+ 3′	9.38199	.24099	9.38535	.24286	9.38868	.24473	9.39201	.24661	9.39531	.24849	*48*
13	.38205	.24102	.38540	.24289	.38874	.24476	.39206	.24664	.39536	.24852	*47*
14	.38210	.24105	.38546	.24292	.38880	.24479	.39212	.24667	.39542	.24855	*46*
15	.38216	.24108	.38551	.24295	.38885	.24482	.39217	.24670	.39547	.24858	*45*
+ 4′	9.38222	.24111	9.38557	.24298	9.38891	.24485	9.39223	.24673	9.39553	.24862	*44*
17	.38227	.24114	.38563	.24301	.38896	.24488	.39228	.24676	.39558	.24865	*43*
18	.38233	.24117	.38568	.24304	.38902	.24492	.39234	.24680	.39564	.24868	*42*
19	.38239	.24120	.38574	.24307	.38907	.24495	.39239	.24683	.39569	.24871	*41*
+ 5′	9.38244	.24124	9.38579	.24310	9.38913	.24498	9.39245	.24686	9.39575	.24874	*40*
21	.38250	.24127	.38585	.24314	.38918	.24501	.39250	.24689	.39580	.24877	*39*
22	.38255	.24130	.38590	.24317	.38924	.24504	.39256	.24692	.39586	.24880	*38*
23	.38261	.24133	.38596	.24320	.38929	.24507	.39261	.24695	.39591	.24884	*37*
+ 6′	9.38267	.24136	9.38602	.24323	9.38935	.24510	9.39267	.24698	9.39597	.24887	*36*
25	.38272	.24139	.38607	.24326	.38941	.24514	.39272	.24701	.39602	.24890	*35*
26	.38278	.24142	.38613	.24329	.38946	.24517	.39278	.24705	.39608	.24893	*34*
27	.38283	.24145	.38618	.24332	.38952	.24520	.39283	.24708	.39613	.24896	*33*
+ 7′	9.38289	.24148	9.38624	.24335	9.38957	.24523	9.39289	.24711	9.39619	.24899	*32*
29	.38295	.24152	.38629	.24339	.38963	.24526	.39294	.24714	.39624	.24902	*31*
30	.38300	.24155	.38635	.24342	.38968	.24529	.39300	.24717	.39630	.24906	*30*
31	.38306	.24158	.38641	.24345	.38974	.24532	.39305	.24720	.39635	.24909	*29*
+ 8′	9.38311	.24161	9.38646	.24348	9.38979	.24535	9.39311	.24723	9.39641	.24912	*28*
33	.38317	.24164	.38652	.24351	.38985	.24539	.39316	.24727	.39646	.24915	*27*
34	.38322	.24167	.38657	.24354	.38990	.24542	.39322	.24730	.39652	.24918	*26*
35	.38328	.24170	.38663	.24357	.38996	.24545	.39327	.24733	.39657	.24921	*25*
+ 9′	9.38334	.24173	9.38668	.24360	9.39002	.24548	9.39333	.24736	9.39663	.24924	*24*
37	.38339	.24176	.38674	.24364	.39007	.24551	.39338	.24739	.39668	.24928	*23*
38	.38345	.24180	.38680	.24367	.39013	.24554	.39344	.24742	.39674	.24931	*22*
39	.38350	.24183	.38685	.24370	.39018	.24557	.39349	.24745	.39679	.24934	*21*
+ 10′	9.38356	.24186	9.38691	.24373	9.39024	.24560	9.39355	.24749	9.39685	.24937	*20*
41	.38362	.24189	.38696	.24376	.39029	.24564	.39360	.24752	.39690	.24940	*19*
42	.38367	.24192	.38702	.24379	.39035	.24567	.39366	.24755	.39695	.24943	*18*
43	.38373	.24195	.38707	.24382	.39040	.24570	.39371	.24758	.39701	.24946	*17*
+ 11′	9.38378	.24198	9.38713	.24385	9.39046	.24573	9.39377	.24761	9.39706	.24950	*16*
45	.38384	.24201	.38719	.24388	.39051	.24576	.39382	.24764	.39712	.24953	*15*
46	.38390	.24204	.38724	.24392	.39057	.24579	.39388	.24767	.39717	.24956	*14*
47	.38395	.24208	.38730	.24395	.39062	.24582	.39393	.24770	.39723	.24959	*13*
+ 12′	9.38401	.24211	9.38735	.24398	9.39068	.24586	9.39399	.24774	9.39728	.24962	*12*
49	.38406	.24214	.38741	.24401	.39073	.24589	.39404	.24777	.39734	.24965	*11*
50	.38412	.24217	.38746	.24404	.39079	.24592	.39410	.24780	.39739	.24969	*10*
51	.38418	.24220	.38752	.24407	.39085	.24595	.39415	.24783	.39745	.24972	*9*
+ 13′	9.38423	.24223	9.38757	.24410	9.39090	.24598	9.39421	.24786	9.39750	.24975	*8*
53	.38429	.24226	.38763	.24413	.39096	.24601	.39426	.24789	.39756	.24978	*7*
54	.38434	.24229	.38769	.24417	.39101	.24604	.39432	.24792	.39761	.24981	*6*
55	.38440	.24233	.38774	.24420	.39107	.24607	.39437	.24796	.39767	.24984	*5*
+ 14′	9.38445	.24236	9.38780	.24423	9.39112	.24611	9.39443	.24799	9.39772	.24987	*4*
57	.38451	.24239	.38785	.24426	.39118	.24614	.39448	.24802	.39778	.24991	*3*
58	.38457	.24242	.38791	.24429	.39123	.24617	.39454	.24805	.39783	.24994	*2*
59	.38462	.24245	.38796	.24432	.39129	.24620	.39459	.24808	.39789	.24997	*1*
+ 15′	9.38468	.24248	9.38802	.24435	9.39134	.24623	9.39465	.24811	9.39794	.25000	*0*
	20h 4m		*20h 3m*		*20h 2m*		*20h 1m*		*20h 0m*		

TABLE 45.

Haversines.

s	$4^h\ 0^m$ 60° 0′		$4^h\ 1^m$ 60° 15′		$4^h\ 2^m$ 60° 30′		$4^h\ 3$
	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log.Ha
0	9.39794	.25000	9.40121	.25189	9.40447	.25379	9.4077
1	.39799	.25003	.40127	.25192	.40453	.25382	.4077
2	.39805	.25006	.40132	.25195	.40458	.25385	.4078
3	.39810	.25009	.40138	.25199	.40463	.25388	.4078
+ 1′	9.39816	.25013	9.40143	.25202	9.40469	.25391	9.4079
5	.39821	.25016	.40149	.25205	.40474	.25395	.4079
6	.39827	.25019	.40154	.25208	.40480	.25398	.4080
7	.39832	.25022	.40159	.25211	.40485	.25401	.4080
+ 2′	9.39838	.25025	9.40165	.25214	9.40490	.25404	9.4081
9	.39843	.25028	.40170	.25218	.40496	.25407	.4082
10	.39849	.25032	.40176	.25221	.40501	.25410	.4082
11	.39854	.25035	.40181	.25224	.40507	.25414	.4083
+ 3′	9.39860	.25038	9.40187	.25227	9.40512	.25417	9.4083
13	.39865	.25041	.40192	.25230	.40518	.25420	.4084
14	.39871	.25044	.40198	.25233	.40523	.25423	.4084
15	.39876	.25047	.40203	.25237	.40528	.25426	.4085
+ 4′	9.39881	.25050	9.40208	.25240	9.40534	.25429	9.4085
17	.39887	.25054	.40214	.25243	.40539	.25433	.4086
18	.39892	.25057	.40219	.25246	.40545	.25436	.4086
19	.39898	.25060	.40225	.25249	.40550	.25439	.4087
+ 5′	9.39903	.25063	9.40230	.25252	9.40555	.25442	9.4087
21	.39909	.25066	.40236	.25255	.40561	.25445	.4088
22	.39914	.25069	.40241	.25259	.40566	.25448	.4089
23	.39920	.25072	.40246	.25262	.40572	.25452	.4089
+ 6′	9.39925	.25076	9.40252	.25265	9.40577	.25455	9.4090
25	.39931	.25079	.40257	.25268	.40582	.25458	.4090
26	.39936	.25082	.40263	.25271	.40588	.25461	.4091
27	.39942	.25085	.40268	.25274	.40593	.25464	4091
+ 7′	9.39947	.25088	9.40274	.25278	9.40599	.25467	9.4092
29	.39952	.25091	.40279	.25281	.40604	.25471	.4092
30	.39958	.25095	.40284	.25284	.40609	.25474	.4093
31	.39963	.25098	.40290	.25287	.40615	.25477	.4093
+ 8′	9.39969	.25101	9.40295	.25290	9.40620	.25480	9.4094
33	.39974	.25104	.40301	.25293	.40626	.25483	.4094
34	.39980	.25107	.40306	.25297	.40631	.25487	.4095
35	.39985	.25110	.40312	.25300	.40636	.25490	.4096
+ 9′	9.39991	.25113	9.40317	.25303	9.40642	.25493	9.4096
37	.39996	.25117	.40322	.25306	.40647	.25496	.4097
38	.40002	.25120	.40328	.25309	.40653	.25499	.4097
39	.40007	.25123	.40333	.25312	.40658	.25502	.4098
+ 10′	9.40012	.25126	9.40339	.25316	9.40663	.25506	9.4098
41	.40018	.25129	.40344	.25319	.40669	.25509	.4099
42	.40023	.25132	.40350	.25322	.40674	.25512	.4099
43	.40029	.25136	.40355	.25325	.40680	.25515	.4100
+ 11′	9.40034	.25139	9.40360	.25328	9.40685	.25518	9.4100
45	.40040	.25142	.40366	.25331	.40690	.25521	.4101
46	.40045	.25145	.40371	.25335	.40696	.25525	.4101
47	.40051	.25148	.40377	.25338	.40701	.25528	.4102
+ 12′	9.40056	.25151	9.40382	.25341	9.40707	.25531	9.4102
49	.40062	.25154	.40388	.25344	.40712	.25534	.4103
50	.40067	.25158	.40393	.25347	.40717	.25537	.4104
51	.40072	.25161	.40398	.25350	.40723	.25540	.4104
+ 13′	9.40078	.25164	9.40404	.25354	9.40728	.25544	9.4105
53	.40083	.25167	.40409	.25357	.40734	.25547	.4105
54	.40089	.25170	.40415	.25360	.40739	.25550	.4106
55	.40094	.25173	.40420	.25363	.40744	.25553	.4106
+ 14′	9.40100	.25177	9.40425	.25366	9.40750	.25556	9.4107
57	.40105	.25180	.40431	.25369	.40755	.25559	.4107
58	.40111	.25183	.40436	.25372	.40761	.25563	.4108
59	.40116	.25186	.40442	.25376	.40766	.25566	.4108
+ 15′	9.40121	.25189	9.40447	.25379	9.40771	.25569	9.4109
	$19^h\ 59^m$		$19^h\ 58^m$		$19^h\ 57^m$		19

TABLE 45.

Haversines.

	$4^h\ 5^m$ 61° 15′		$4^h\ 6^m$ 61° 30′		$4^h\ 7^m$ 61° 45′		$4^h\ 8^m$ 62° 0′		$4^h\ 9^m$ 62° 15′		
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	s
0	9.41415	**.25951**	9.41734	**.26142**	9.42052	**.26334**	9.42368	**.26526**	9.42682	**.26719**	*60*
1	.41420	**.25954**	.41739	**.26145**	.42057	**.26337**	.42373	**.26530**	.42688	**.26722**	*59*
2	.41425	**.25957**	.41745	**.26148**	.42062	**.26340**	.42378	**.26533**	.42693	**.26726**	*58*
3	.41431	**.25960**	.41750	**.26152**	.42068	**.26344**	.42384	**.26536**	.42698	**.26729**	*57*
+ 1′	9.41436	**.25963**	9.41755	**.26155**	9.42073	**.26347**	9.42389	**.26539**	9.42703	**.26732**	*56*
5	.41441	**.25966**	.41761	**.26158**	.42078	**.26350**	.42394	**.26543**	.42709	**.26735**	*55*
6	.41447	**.25970**	.41766	**.26161**	.42083	**.26353**	.42399	**.26546**	.42714	**.26739**	*54*
7	.41452	**.25973**	.41771	**.26164**	.42089	**.26356**	.42405	**.26549**	.42719	**.26742**	*53*
+ 2′	9.41457	**.25976**	9.41776	**.26168**	9.42094	**.26360**	9.42410	**.26552**	9.42724	**.26745**	*52*
9	.41463	**.25979**	.41782	**.26171**	.42099	**.26363**	.42415	**.26555**	.42730	**.26748**	*51*
10	.41468	**.25982**	.41787	**.26174**	.42105	**.26366**	.42420	**.26559**	.42735	**.26751**	*50*
11	.41473	**.25986**	.41792	**.26177**	.42110	**.26369**	.42426	**.26562**	.42740	**.26755**	*49*
+ 3′	9.41479	**.25989**	9.41798	**.26180**	9.42115	**.26372**	9.42431	**.26565**	9.42745	**.26758**	*48*
13	.41484	**.25992**	.41803	**.26184**	.42120	**.26376**	.42436	**.26568**	.42750	**.26761**	*47*
14	.41489	**.25995**	.41808	**.26187**	.42126	**.26379**	.42441	**.26571**	.42756	**.26764**	*46*
15	.41495	**.25998**	.41814	**.26190**	.42131	**.26382**	.42447	**.26575**	.42761	**.26768**	*45*
+ 4′	9.41500	**.26002**	9.41819	**.26193**	9.42136	**.26385**	9.42452	**.26578**	9.42766	**.26771**	*44*
17	.41505	**.26005**	.41824	**.26196**	.42141	**.26389**	.42457	**.26581**	.42771	**.26774**	*43*
18	.41511	**.26008**	.41829	**.26200**	.42147	**.26392**	.42462	**.26584**	.42777	**.26777**	*42*
19	.41516	**.26011**	.41835	**.26203**	.42152	**.26395**	.42468	**.26587**	.42782	**.26780**	*41*
+ 5′	9.41521	**.26014**	9.41840	**.26206**	9.42157	**.26398**	9.42473	**.26591**	9.42787	**.26784**	*40*
21	.41527	**.26017**	.41845	**.26209**	.42163	**.26402**	.42478	**.26594**	.42792	**.26787**	*39*
22	.41532	**.26021**	.41851	**.26212**	.42168	**.26405**	.42483	**.26597**	.42797	**.26790**	*38*
23	.41537	**.26024**	.41856	**.26216**	.42173	**.26408**	.42489	**.26600**	.42803	**.26793**	*37*
+ 6′	9.41543	**.26027**	9.41861	**.26219**	9.42178	**.26411**	9.42494	**.26604**	9.42808	**.26797**	*36*
25	.41548	**.26030**	.41867	**.26222**	.42184	**.26414**	.42499	**.26607**	.42813	**.26800**	*35*
26	.41553	**.26033**	.41872	**.26225**	.42189	**.26417**	.42504	**.26610**	.42818	**.26803**	*34*
27	.41559	**.26037**	.41877	**.26228**	.42194	**.26421**	.42510	**.26613**	.42824	**.26806**	*33*
+ 7′	9.41564	**.26040**	9.41882	**.26232**	9.42199	**.26424**	9.42515	**.26616**	9.42829	**.26809**	*32*
29	.41569	**.26043**	.41888	**.26235**	.42205	**.26427**	.42520	**.26620**	.42834	**.26813**	*31*
30	.41575	**.26046**	.41893	**.26238**	.42210	**.26430**	.42525	**.26623**	.42839	**.26816**	*30*
31	.41580	**.26049**	.41898	**.26241**	.42215	**.26433**	.42531	**.26626**	.42844	**.26819**	*29*
+ 8′	9.41585	**.26053**	9.41904	**.26244**	9.42221	**.26437**	9.42536	**.26629**	9.42850	**.26822**	*28*
33	.41590	**.26056**	.41909	**.26248**	.42226	**.26440**	.42541	**.26632**	.42855	**.26826**	*27*
34	.41596	**.26059**	.41914	**.26251**	.42231	**.26443**	.42546	**.26636**	.42860	**.26829**	*26*
35	.41601	**.26062**	.41920	**.26254**	.42236	**.26446**	.42552	**.26639**	.42865	**.26832**	*25*
+ 9′	9.41606	**.26065**	9.41925	**.26257**	9.42242	**.26449**	9.42557	**.26642**	9.42870	**.26835**	*24*
37	.41612	**.26069**	.41930	**.26260**	.42247	**26453**	.42562	**.26645**	.42876	**.26838**	*23*
38	.41617	**.26072**	.41935	**.26264**	.42252	**.26456**	.42567	**.26649**	.42881	**.26842**	*22*
39	.41622	**.26075**	.41941	**.26267**	.42257	**.26459**	.42573	**.26652**	.42886	**.26845**	*21*
+ 10′	9.41628	**.26078**	9.41946	**.26270**	9.42263	**.26462**	9.42578	**.26655**	9.42891	**.26848**	*20*
41	.41633	**.26081**	.41951	**.26273**	.42268	**.26465**	.42583	**.26658**	.42897	**.26851**	*19*
42	41638	**.26085**	.41957	**.26276**	.42273	**.26469**	.42588	**.26661**	.42902	**.26855**	*18*
43	.41644	**.26088**	.41962	**.26280**	.42278	**.26472**	.42593	**.26665**	.42907	**.26858**	*17*
+ 11′	9.41649	**.26091**	9.41967	**.26283**	9.42284	**.26475**	9.42599	**.26668**	9.42912	**.26861**	*16*
45	.41654	**.26094**	.41972	**.26286**	.42289	**.26478**	.42604	**.26671**	.42917	**.26864**	*15*
46	.41660	**.26097**	.41978	**.26289**	.42294	**.26481**	.42609	**.26674**	.42923	**.26867**	*14*
47	.41665	**.26101**	.41983	**.26292**	.42300	**.26485**	.42614	**.26677**	.42928	**.26871**	*13*
+ 12′	9.41670	**.26104**	9.41988	**.26296**	9.42305	**.26488**	9.42620	**.26681**	9.42933	**.26874**	*12*
49	.41676	**.26107**	.41994	**.26299**	.42310	**.26491**	.42625	**.26684**	.42938	**.26877**	*11*
50	.41681	**.26110**	.41999	**.26302**	.42315	**.26494**	.42630	**.26687**	.42943	**.26880**	*10*
51	.41686	**.26113**	.42004	**.26305**	.42321	**.26498**	.42635	**.26690**	.42949	**.26883**	*9*
+ 13′	9.41692	**.26117**	9.42009	**.26308**	9.42326	**.26501**	9.42641	**.26694**	9.42954	**.26887**	*8*
53	.41697	**.26120**	.42015	**.26312**	.42331	**.26504**	.42646	**.26697**	.42959	**.26890**	*7*
54	.41702	**.26123**	.42020	**.26315**	.42336	**.26507**	.42651	**.26700**	.42964	**.26893**	*6*
55	.41707	**.26126**	.42025	**.26318**	.42342	**.26510**	.42656	**.26703**	.42969	**.26896**	*5*
+ 14′	9.41713	**.26129**	9.42031	**.26321**	9.42347	**.26514**	9.42662	**.26706**	9.42975	**.26900**	*4*
57	.41718	**.26132**	.42036	**.26324**	.42352	**.26517**	.42667	**.26710**	.42980	**.26903**	*3*
58	.41723	**.26136**	.42041	**.26328**	.42357	**.26520**	.42672	**.26713**	.42985	**.26906**	*2*
59	.41729	**.26139**	.42046	**.26331**	.42363	**.26523**	.42677	**.26716**	.42990	**.26909**	*1*
+ 15′	9.41734	**.26142**	9.42052	**.26334**	9.42368	**.26526**	9.42682	**.26719**	9.42996	**.26913**	*0*
	$19^h\ 54^m$		$19^h\ 53^m$		$19^h\ 52^m$		$19^h\ 51^m$		$19^h\ 50^m$		

TABLE 45.

Haversines.

s	4h 15m 63° 45′		4h 16m 64° 0′		4h 17m 64° 15′		4h 18m 64° 30′		4h 19m 64° 45′		s
	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	s
0	9.44538	.27886	9.44842	.28081	9.45144	.28278	9.45446	.28474	9.45745	.28672	60
1	.44543	.27889	.44847	.28085	.45149	.28281	.45451	.28478	.45750	.28675	59
2	.44548	.27892	.44852	.28088	.45155	.28284	.45456	.28481	.45755	.28678	58
3	.44553	.27895	.44857	.28091	.45160	.28288	.45461	.28484	.45760	.28681	57
+ 1′	9.44558	.27899	9.44862	.28095	9.45165	.28291	9.45466	.28488	9.45765	.28685	56
5	.44563	.27902	.44867	.28098	.45170	.28294	.45471	.28491	.45770	.28688	55
6	.44568	.27905	.44872	.28101	.45175	.28297	.45476	.28494	.45775	.28691	54
7	.44573	.27908	.44877	.28104	.45180	.28301	.45481	.28497	.45780	.28695	53
+ 2′	9.44579	.27912	9.44882	.28108	9.45185	.28304	9.45486	.28501	9.45785	.28698	52
9	.44584	.27915	.44887	.28111	.45190	.28307	.45491	.28504	.45790	.28701	51
10	.44589	.27918	.44892	.28114	.45195	.28310	.45496	.28507	.45795	.28704	50
11	.44594	.27921	.44898	.28117	.45200	.28314	.45501	.28511	.45800	.28708	49
+ 3′	9.44599	.27925	9.44903	.28121	9.45205	.28317	9.45506	.28514	9.45805	.28711	48
13	.44604	.27928	.44908	.28124	.45210	.28320	.45511	.28517	.45810	.28714	47
14	.44609	.27931	.44913	.28127	.45215	.28324	.45516	.28520	.45815	.28718	46
15	.44614	.27935	.44918	.28130	.45220	.28327	.45521	.28524	.45820	.28721	45
+ 4′	9.44619	.27938	9.44923	.28134	9.45225	.28330	9.45526	.28527	9.45825	.28724	44
17	.44624	.27941	.44928	.28137	.45230	.28333	.45531	.28530	.45830	.28727	43
18	.44629	.27944	.44933	.28140	.45235	.28337	.45536	.28534	.45835	.28731	42
19	.44634	.27948	.44938	.28144	.45240	.28340	.45541	.28537	.45840	.28734	41
+ 5′	9.44639	.27951	9.44943	.28147	9.45245	.28343	9.45546	.28540	9.45845	.28737	40
21	.44645	.27954	.44948	.28150	.45250	.28347	.45551	.28543	.45850	.28741	39
22	.44650	.27957	.44953	.28153	.45255	.28350	.45556	.28547	.45855	.28744	38
23	.44655	.27961	.44958	.28157	.45260	.28353	.45561	.28550	.45860	.28747	37
+ 6′	9.44660	.27964	9.44963	.28160	9.45265	.28356	9.45566	.28553	9.45865	.28751	36
25	.44665	.27967	.44968	.28163	.45270	.28360	.45571	.28557	.45870	.28754	35
26	.44670	.27970	.44973	.28166	.45275	.28363	.45576	.28560	.45875	.28757	34
27	.44675	.27974	.44978	.28170	.45280	.28366	.45581	.28563	.45879	.28760	33
+ 7′	9.44680	.27977	9.44983	.28173	9.45285	.28369	9.45586	.28566	9.45884	.28764	32
29	.44685	.27980	.44988	.28176	.45290	.28373	.45591	.28570	.45889	.28767	31
30	.44690	.27983	.44993	.28180	.45295	.28376	.45596	.28573	.45894	.28770	30
31	.44695	.27987	.44998	.28183	.45300	.28379	.45601	.28576	.45899	.28774	29
+ 8′	9.44700	.27990	9.45003	.28186	9.45305	.28383	9.45606	.28580	9.45904	.28777	28
33	.44705	.27993	.45009	.28189	.45310	.28386	.45610	.28583	.45909	.28780	27
34	.44710	.27997	.45014	.28193	.45315	.28389	.45615	.28586	.45914	.28783	26
35	.44715	.28000	.45019	.28196	.45320	.28392	.45620	.28589	.45919	.28787	25
+ 9′	9.44721	.28003	9.45024	.28199	9.45325	.28396	9.45625	.28593	9.45924	.28790	24
37	.44726	.28006	.45029	.28202	.45330	.28399	.45630	.28596	.45929	.28793	23
38	.44731	.28010	.45034	.28206	.45335	.28402	.45635	.28599	.45934	.28797	22
39	.44736	.28013	.45039	.28209	.45340	.28406	.45640	.28603	.45939	.28800	21
+ 10′	9.44741	.28016	9.45044	.28212	9.45345	.28409	9.45645	.28606	9.45944	.28803	20
41	.44746	.28019	.45049	.28216	.45350	.28412	.45650	.28609	.45949	.28807	19
42	.44751	.28023	.45054	.28219	.45355	.28415	.45655	.28612	.45954	.28810	18
43	.44756	.28026	.45059	.28222	.45360	.28419	.45660	.28616	.45959	.28813	17
+ 11′	9.44761	.28029	9.45064	.28225	9.45365	.28422	9.45665	.28619	9.45964	.28816	16
45	.44766	.28032	.45069	.28229	.45370	.28425	.45670	.28622	.45969	.28820	15
46	.44771	.28036	.45074	.28232	.45375	.28429	.45675	.28626	.45974	.28823	14
47	.44776	.28039	.45079	.28235	.45380	.28432	.45680	.28629	.45979	.28826	13
+ 12′	9.44781	.28042	9.45084	.28238	9.45385	.28435	9.45685	.28632	9.45984	.28830	12
49	.44786	.28046	.45089	.28242	.45390	.28438	.45690	.28635	.45989	.28833	11
50	.44791	.28049	.45094	.28245	.45395	.28442	.45695	.28639	.45994	.28836	10
51	.44796	.28052	.45099	.28248	.45400	.28445	.45700	.28642	.45999	.28840	9
+ 13′	9.44801	.28055	9.45104	.28252	9.45405	.28448	9.45705	.28645	9.46004	.28843	8
53	.44807	.28059	.45109	.28255	.45410	.28451	.45710	.28649	.46009	.28846	7
54	.44812	.28062	.45114	.28258	.45415	.28455	.45715	.28652	.46014	.28849	6
55	.44817	.28065	.45119	.28261	.45420	.28458	.45720	.28655	.46019	.28853	5
+ 14′	9.44822	.28068	9.45124	.28265	9.45426	.28461	9.45725	.28658	9.46023	.28856	4
57	.44827	.28072	.45129	.28268	.45431	.28465	.45730	.28662	.46028	.28859	3
58	.44832	.28075	.45134	.28271	.45436	.28468	.45735	.28665	.46033	.28863	2
59	.44837	.28078	.45139	.28274	.45441	.28471	.45740	.28668	.46038	.28866	1
+ 15′	9.44842	.28081	9.45144	.28278	9.45446	.28474	9.45745	.28672	9.46043	.28869	0
	19h 44m		19h 43m		19h 42m		19h 41m		19h 40m		

TABLE 45.

Haversines.

s	$4^h\ 25^m$ 66° 15′		$4^h\ 26^m$ 66° 30′		$4^h\ 27^m$ 66° 45′		$4^h\ 28^m$ 67° 0′		$4^h\ 29^m$ 67° 15′		s
	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	
0	9.47513	.29863	9.47803	.30063	9.48091	.30263	9.48378	.30463	9.48664	.30664	60
1	.47518	.29866	.47807	.30066	.48096	.30266	.48383	.30467	.48668	.30668	59
2	.47523	.29869	.47812	.30069	.48101	.30269	.48387	.30470	.48673	.30671	58
3	.47527	.29873	.47817	.30073	.48105	.30273	.48392	.30473	.48678	.30675	57
+ 1′	9.47532	.29876	9.47822	.30076	9.48110	.30276	9.48397	.30477	9.48683	.30678	56
5	.47537	.29879	.47827	.30079	.48115	.30280	.48402	.30480	.48687	.30681	55
6	.47542	.29883	.47831	.30083	.48120	.30283	.48407	.30484	.48692	.30685	54
7	.47547	.29886	.47836	.30086	.48124	.30286	.48411	.30487	.48697	.30688	53
+ 2′	9.47552	.29889	9.47841	.30089	9.48129	.30290	9.48416	.30490	9.48702	.30691	52
9	.47556	.29893	.47846	.30093	.48134	.30293	.48421	.30494	.48706	.30695	51
10	.47561	.29896	.47851	.30096	.48139	.30296	.48426	.30497	.48711	.30698	50
11	.47566	.29899	.47856	.30099	.48144	.30300	.48430	.30500	.48716	.30701	49
+ 3′	9.47571	.29903	9.47860	.30103	9.48148	.30303	9.48435	.30504	9.48720	.30705	48
13	.47576	.29906	.47865	.30106	.48153	.30306	.48440	.30507	.48725	.30708	47
14	.47581	.29909	.47870	.30109	.48158	.30310	.48445	.30510	.48730	.30711	46
15	.47585	.29913	.47875	.30113	.48163	.30313	.48449	.30514	.48735	.30715	45
+ 4′	9.47590	.29916	9.47880	.30116	9.48168	.30316	9.48454	.30517	9.48739	.30718	44
17	.47595	.29919	.47884	.30119	.48172	.30320	.48459	.30520	.48744	.30721	43
18	.47600	.29923	.47889	.30123	.48177	.30323	.48464	.30524	.48749	.30725	42
19	.47605	.29926	.47894	.30126	.48182	.30326	.48468	.30527	.48754	.30728	41
+ 5′	9.47610	.29929	9.47899	.30129	9.48187	.30330	9.48473	.30530	9.48758	.30732	40
21	.47614	.29933	.47904	.30133	.48192	.30333	.48478	.30534	.48763	.30735	39
22	.47619	.29936	.47908	.30136	.48196	.30336	.48483	.30537	.48768	.30738	38
23	.47624	.29939	.47913	.30139	.48201	.30340	.48488	.30540	.48773	.30742	37
+ 6′	9.47629	.29943	9.47918	.30143	9.48206	.30343	9.48492	.30544	9.48777	.30745	36
25	.47634	.29946	.47923	.30146	.48211	.30346	.48497	.30547	.48782	.30748	35
26	.47639	.29949	.47928	.30149	.48215	.30350	.48502	.30551	.48787	.30752	34
27	.47643	.29953	.47933	.30153	.48220	.30353	.48507	.30554	.48792	.30755	33
+ 7′	9.47648	.29956	9.47937	.30156	9.48225	.30356	9.48511	.30557	9.48796	.30758	32
29	.47653	.29959	.47942	.30159	.48230	.30360	.48516	.30561	.48801	.30762	31
30	.47658	.29963	.47947	.30163	.48235	.30363	.48521	.30564	.48806	.30765	30
31	.47663	.29966	.47952	.30166	.48239	.30366	.48526	.30567	.48811	.30768	29
+ 8′	9.47668	.29969	9.47957	.30169	9.48244	.30370	9.48530	.30571	9.48815	.30772	28
33	.47672	.29973	.47961	.30173	.48249	.30373	.48535	.30574	.48820	.30775	27
34	.47677	.29976	.47966	.30176	.48254	.30376	.48540	.30577	.48825	.30779	26
35	.47682	.29979	.47971	.30179	.48258	.30380	.48545	.30581	.48830	.30782	25
+ 9′	9.47687	.29983	9.47976	.30183	9.48263	.30383	9.48549	.30584	9.48834	.30785	24
37	.47692	.29986	.47981	.30186	.48268	.30386	.48554	.30587	.48839	.30789	23
38	.47697	.29989	.47985	.30189	.48273	.30390	.48559	.30591	.48844	.30792	22
39	.47701	.29993	.47990	.30193	.48278	.30393	.48564	.30594	.48848	.30795	21
+ 10′	9.47706	.29996	9.47995	.30196	9.48282	.30397	9.48568	.30597	9.48853	.30799	20
41	.47711	.29999	.48000	.30199	.48287	.30400	.48573	.30601	.48858	.30802	19
42	.47716	.30003	.48005	.30203	.48292	.30403	.48578	.30604	.48863	.30805	18
43	.47721	.30006	.48009	.30206	.48297	.30407	.48583	.30607	.48867	.30809	17
+ 11′	9.47725	.30009	9.48014	.30209	9.48302	.30410	9.48587	.30611	9.48872	.30812	16
45	.47730	.30013	.48019	.30213	.48306	.30413	.48592	.30614	.48877	.30815	15
46	.47735	.30016	.48024	.30216	.48311	.30417	.48597	.30618	.48882	.30819	14
47	.47740	.30019	.48029	.30219	.48316	.30420	.48602	.30621	.48886	.30822	13
+ 12′	9.47745	.30023	9.48033	.30223	9.48321	.30423	9.48607	.30624	9.48891	.30826	12
49	.47750	.30026	.48038	.30226	.48325	.30427	.48611	.30628	.48896	.30829	11
50	.47754	.30029	.48043	.30229	.48330	.30430	.48616	.30631	.48901	.30832	10
51	.47759	.30033	.48048	.30233	.48335	.30433	.48621	.30634	.48905	.30836	9
+ 13′	9.47764	.30036	9.48053	.30236	9.48340	.30437	9.48626	.30638	9.48910	.30839	8
53	.47769	.30039	.48057	.30239	.48344	.30440	.48630	.30641	.48915	.30842	7
54	.47774	.30043	.48062	.30243	.48349	.30443	.48635	.30644	.48919	.30846	6
55	.47778	.30046	.48067	.30246	.48354	.30447	.48640	.30648	.48924	.30849	5
+ 14′	9.47783	.30049	9.48072	.30249	9.48359	.30450	9.48645	.30651	9.48929	.30852	4
57	.47788	.30053	.48077	.30253	.48364	.30453	.48649	.30654	.48934	.30856	3
58	.47793	.30056	.48081	.30256	.48368	.30457	.48654	.30658	.48938	.30859	2
59	.47798	.30059	.48086	.30259	.48373	.30460	.48659	.30661	.48943	.30862	1
+ 15′	9.47803	.30063	9.48091	.30263	9.48378	.30463	9.48664	.30664	9.48948	.30866	0
	$19^h\ 34^m$		$19^h\ 33^m$		$19^h\ 32^m$		$19^h\ 31^m$		$19^h\ 30^m$		

TABLE 45.

Haversines.

	$4^{h}\ 35^{m}$ 68° 45′		$4^{h}\ 36^{m}$ 69° 0′		$4^{h}\ 37^{m}$ 69° 15′		$4^{h}\ 38^{m}$ 69° 30′		$4^{h}\ 39^{m}$ 69° 45′		
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	s
0	9.50349	.31878	9.50626	.32082	9.50901	.32285	9.51174	.32490	9.51447	.32694	60
1	.50354	.31881	.50630	.32085	.50905	.32289	.51179	.32493	.51452	.32698	59
2	.50358	.31885	.50635	.32088	.50910	.32292	.51184	.32496	.51456	.32701	58
3	.50363	.31888	.50639	.32092	.50914	.32296	.51188	.32500	.51461	.32704	57
+ 1′	9.50368	.31892	9.50644	.32095	9.50919	.32299	9.51193	.32503	9.51465	.32708	56
5	.50372	.31895	.50649	.32099	.50924	.32302	.51197	.32507	.51470	.32711	55
6	.50377	.31898	.50653	.32102	.50928	.32306	.51202	.32510	.51474	.32715	54
7	.50382	.31902	.50658	.32105	.50933	.32309	.51206	.32513	.51479	.32718	53
+ 2′	9.50386	.31905	9.50662	.32109	9.50937	.32313	9.51211	.32517	9.51483	.32721	52
9	.50391	.31909	.50667	.32112	.50942	.32316	.51215	.32520	.51488	.32725	51
10	.50395	.31912	.50672	.32116	.50946	.32319	.51220	.32524	.51492	.32728	50
11	.50400	.31915	.50676	.32119	.50951	.32323	.51225	.32527	.51497	.32732	49
+ 3′	9.50405	.31919	9.50681	.32122	9.50956	.32326	9.51229	.32531	9.51501	.32735	48
13	.50409	.31922	.50685	.32126	.50960	.32330	.51234	.32534	.51506	.32738	47
14	.50414	.31926	.50690	.32129	.50965	.32333	.51238	.32537	.51510	.32742	46
15	.50418	.31929	.50694	.32133	.50969	.32336	.51243	.32541	.51515	.32745	45
+ 4′	9.50423	.31932	9.50699	.32136	9.50974	.32340	9.51247	.32544	9.51519	.32749	44
17	.50428	.31936	.50704	.32139	.50978	.32343	.51252	.32547	.51524	.32752	43
18	.50432	.31939	.50708	.32143	.50983	.32347	.51256	.32551	.51529	.32756	42
19	.50437	.31942	.50713	.32146	.50988	.32350	.51261	.32554	.51533	.32759	41
+ 5′	9.50442	.31946	9.50717	.32150	9.50992	.32353	9.51265	.32558	9.51538	.32762	40
21	.50446	.31949	.50722	.32153	.50997	.32357	.51270	.32561	.51542	.32766	39
22	.50451	.31953	.50727	.32156	.51001	.32360	.51275	.32565	.51547	.32769	38
23	.50455	.31956	.50731	.32160	.51006	.32364	.51279	.32568	.51551	.32773	37
+ 6′	9.50460	.31959	9.50736	.32163	9.51010	.32367	9.51284	.32571	9.51556	.32776	36
25	.50465	.31963	.50740	.32166	.51015	.32370	.51288	.32575	.51560	.32779	35
26	.50469	.31966	.50745	.32170	.51019	.32374	.51293	.32578	.51565	.32783	34
27	.50474	.31970	.50750	.32173	.51024	.32377	.51297	.32582	.51569	.32786	33
+ 7′	9.50478	.31973	9.50754	.32177	9.51029	.32381	9.51302	.32585	9.51574	.32790	32
29	.50483	.31976	.50759	.32180	.51033	.32384	.51306	.32588	.51578	.32793	31
30	.50488	.31980	.50763	.32183	.51038	.32388	.51311	.32592	.51583	.32797	30
31	.50492	.31983	.50768	.32187	.51042	.32391	.51315	.32595	.51587	.32800	29
+ 8′	9.50497	.31987	9.50772	.32190	9.51047	.32394	9.51320	.32599	9.51592	.32803	28
33	.50501	.31990	.50777	.32194	.51051	.32398	.51325	.32602	.51596	.32807	27
34	.50506	.31993	.50782	.32197	.51056	.32401	.51329	.32605	.51601	.32810	26
35	.50511	.31997	.50786	.32200	.51061	.32405	.51334	.32609	.51605	.32814	25
+ 9′	9.50515	.32000	9.50791	.32204	9.51065	.32408	9.51338	.32612	9.51610	.32817	24
37	.50520	.32004	.50795	.32207	.51070	.32411	.51343	.32616	.51614	.32820	23
38	.50524	.32007	.50800	.32211	.51074	.32415	.51347	.32619	.51619	.32824	22
39	.50529	.32010	.50805	.32214	.51079	.32418	.51352	.32623	.51623	.32827	21
+ 10′	9.50534	.32014	9.50809	.32217	9.51083	.32422	9.51356	.32626	9.51628	.32831	20
41	.50538	.32017	.50814	.32221	.51088	.32425	.51361	.32629	.51633	.32834	19
42	.50543	.32021	.50818	.32224	.51092	.32428	.51365	.32633	.51637	.32837	18
43	.50547	.32024	.50823	.32228	.51097	.32432	.51370	.32636	.51642	.32841	17
+ 11′	9.50552	.32027	9.50827	.32231	9.51102	.32435	9.51374	.32640	9.51646	.32844	16
45	.50557	.32031	.50832	.32235	.51106	.32438	.51379	.32643	.51651	.32848	15
46	.50561	.32034	.50837	.32238	.51111	.32442	.51384	.32646	.51655	.32851	14
47	.50566	.32037	.50841	.32241	.51115	.32445	.51388	.32650	.51660	.32855	13
+ 12′	9.50570	.32041	9.50846	.32245	9.51120	.32449	9.51393	.32653	9.51664	.32858	12
49	.50575	.32044	.50850	.32248	.51124	.32452	.51397	.32657	.51669	.32861	11
50	.50580	.32048	.50855	.32251	.51129	.32456	.51402	.32660	.51673	.32865	10
51	.50584	.32051	.50860	.32255	.51133	.32459	.51406	.32663	.51678	.32868	9
+ 13′	9.50589	.32054	9.50864	.32258	9.51138	.32462	9.51411	.32667	9.51682	.32872	8
53	.50593	.32058	.50869	.32262	.51143	.32466	.51415	.32670	.51687	.32875	7
54	.50598	.32061	.50873	.32265	.51147	.32469	.51420	.32674	.51691	.32878	6
55	.50603	.32065	.50878	.32268	.51152	.32473	.51424	.32677	.51696	.32882	5
+ 14′	9.50607	.32068	9.50882	.32272	9.51156	.32476	9.51429	.32681	9.51700	.32885	4
57	.50612	.32071	.50887	.32275	.51161	.32479	.51433	.32684	.51705	.32889	3
58	.50616	.32075	.50892	.32279	.51165	.32483	.51438	.32687	.51709	.32892	2
59	.50621	.32078	.50896	.32282	.51170	.32486	.51442	.32691	.51714	.32896	1
+ 15′	9.50626	.32082	9.50901	.32285	9.51174	.32490	9.51447	.32694	9.51718	.32899	0
	$19^{h}\ 24^{m}$		$19^{h}\ 23^{m}$		$19^{h}\ 22^{m}$		$19^{h}\ 21^{m}$		$19^{h}\ 20^{m}$		

Haversines.

	$4^h\ 40^m$ 70° 0′		$4^h\ 41^m$ 70° 15′		$4^h\ 42^m$ 70° 30′	
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.
0	9.51718	.32899	9.51988	.33104	9.52257	.33310
1	.51723	.32902	.51993	.33108	.52261	.33313
2	.51727	.32906	.51997	.33111	.52266	.33317
3	.51732	.32909	.52002	.33114	.52270	.33320
+ 1′	9.51736	.32913	9.52006	.33118	9.52275	.33323
5	.51741	.32916	.52011	.33121	.52279	.33327
6	.51745	.32920	.52015	.33125	.52284	.33330
7	.51750	.32923	.52020	.33128	.52288	.33334
+ 2′	9.51754	.32926	9.52024	.33132	9.52293	.33337
9	.51759	.32930	.52029	.33135	.52297	.33341
10	.51763	.32933	.52033	.33138	.52302	.33344
11	.51768	.32937	.52038	.33142	.52306	.33347
+ 3′	9.51772	.32940	9.52042	.33145	9.52311	.33351
13	.51777	.32943	.52047	.33149	.52315	.33354
14	.51781	.32947	.52051	.33152	.52320	.33358
15	.51786	.32950	.52056	.33156	.52324	.33361
+ 4′	9.51790	.32954	9.52060	.33159	9.52328	.33365
17	.51795	.32957	.52065	.33162	.52333	.33368
18	.51799	.32961	.52069	.33166	.52337	.33371
19	.51804	.32961	.52074	.33169	.52342	.33375
+ 5′	9.51808	.32967	9.52078	.33173	9.52346	.33378
21	.51813	.32971	.52082	.33176	.52351	.33382
22	.51817	.32974	.52087	.33179	.52355	.33385
23	.51822	.32978	.52091	.33183	.52360	.33389
+ 6′	9.51826	.32981	9.52096	.33186	9.52364	.33392
25	.51831	.32984	.52100	.33190	.52369	.33395
26	.51835	.32988	.52105	.33193	.52373	.33399
27	.51840	.32991	.52109	.33197	.52378	.33402
+ 7′	9.51844	.32995	9.52114	.33200	9.52382	.33406
29	.51849	.32998	.52118	.33203	.52386	.33409
30	.51853	.33002	.52123	.33207	.52391	.33413
31	.51858	.33005	.52127	.33210	.52395	.33416
+ 8′	9.51862	.33008	9.52132	.33214	9.52400	.33419
33	.51867	.33012	.52136	.33217	.52404	.33423
34	.51871	.33015	.52141	.33221	.52409	.33426
35	.51876	.33019	.52145	.33224	.52413	.33430
+ 9′	9.51880	.33022	9.52150	.33227	9.52418	.33433
37	.51885	.33025	.52154	.33231	.52422	.33436
38	.51889	.33029	.52159	.33234	.52427	.33440
39	.51894	.33032	.52163	.33238	.52431	.33444
+ 10′	9.51898	.33036	9.52168	.33241	9.52436	.33447
41	.51903	.33039	.52172	.33245	.52440	.33450
42	.51907	.33043	.52177	.33248	.52444	.33454
43	.51912	.33046	.52181	.33251	.52449	.33457
+ 11′	9.51916	.33049	9.52185	.33255	9.52453	.33461
45	.51921	.33053	.52190	.33258	.52458	.33464
46	.51925	.33056	.52194	.33262	.52462	.33467
47	.51930	.33060	.52199	.33265	.52467	.33471
+ 12′	9.51934	.33063	9.52203	.33269	9.52471	.33474
49	.51939	.33067	.52208	.33272	.52476	.33478
50	.51943	.33070	.52212	.33275	.52480	.33481
51	.51948	.33073	.52217	.33279	.52484	.33485
+ 13′	9.51952	.33077	9.52221	.33282	9.52489	.33488
53	.51957	.33080	.52226	.33286	.52493	.33491
54	.51961	.33084	.52230	.33289	.52498	.33495
55	.51966	.33087	.52235	.33293	.52502	.33498
+ 14′	9.51970	.33090	9.52239	.33296	9.52507	.33502
57	.51975	.33094	.52244	.33296	.52511	.33505
58	.51979	.33097	.52248	.33303	.52516	.33509
59	.51984	.33101	.52253	.33306	.52520	.33512
+ 15′	9.51988	.33104	9.52257	.33310	9.52525	.33515
	$19^h\ 19^m$		$19^h\ 18^m$		$19^h\ 17^m$	

TABLE 45.

Haversines.

	$4^h 45^m$ 71° 15′		$4^h 46^m$ 71° 30′		$4^h 47^m$ 71° 45′		$4^h 48^m$ 72° 0′		$4^h 49^m$ 72° 15′		
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	s
0	9.53056	.33928	9.53320	.34135	9.53582	.34342	9.53844	.34549	9.54104	.34757	60
1	.53060	.33931	.53324	.34138	.53587	.34345	.53848	.34553	.54108	.34760	59
2	.53065	.33935	.53328	.34142	.53591	.34349	.53852	.34556	.54113	.34764	58
3	.53069	.33938	.53333	.34145	.53595	.34352	.53857	.34560	.54117	.34767	57
+ 1′	9.53073	.33942	9.53337	.34149	9.53600	.34356	9.53861	.34563	9.54121	.34771	56
5	.53078	.33945	.53342	.34152	.53604	.34359	.53865	.34566	.54126	.34774	55
6	.53082	.33949	.53346	.34155	.53609	.34363	.53870	.34570	.54130	.34778	54
7	.53087	.33952	.53350	.34159	.53613	.34366	.53874	.34573	.54134	.34781	53
+ 2′	9.53091	.33956	9.53355	.34162	9.53617	.34369	9.53879	.34577	9.54139	.34784	52
9	.53096	.33959	.53359	.34166	.53622	.34373	.53883	.34580	.54143	.34788	51
10	.53100	.33962	.53364	.34169	.53626	.34376	.53887	.34584	.54147	.34791	50
11	.53104	.33966	.53368	.34173	.53630	.34380	.53892	.34587	.54152	.34795	49
+ 3′	9.53109	.33969	9.53372	.34176	9.53635	.34383	9.53896	.34591	9.54156	.34798	48
13	.53113	.33973	.53377	.34180	.53639	.34387	.53900	.34594	.54160	.34802	47
14	.53118	.33976	.53381	.34183	.53643	.34390	.53905	.34598	.54165	.34805	46
15	.53122	.33980	.53385	.34186	.53648	.34394	.53909	.34601	.54169	.34809	45
+ 4′	9.53126	.33983	9.53390	.34190	9.53652	.34397	9.53913	.34604	9.54173	.34812	44
17	.53131	.33986	.53394	.34193	.53657	.34400	.53918	.34608	.54177	.34816	43
18	.53135	.33990	.53399	.34197	.53661	.34404	.53922	.34611	.54182	.34819	42
19	.53140	.33993	.53403	.34200	.53665	.34407	.53926	.34615	.54186	.34823	41
+ 5′	9.53144	.33997	9.53407	.34204	9.53670	.34411	9.53931	.34618	9.54190	.34826	40
21	.53148	.34000	.53412	.34207	.53674	.34414	.53935	.34622	.54195	.34830	39
22	.53153	.34004	.53416	.34211	.53678	.34418	.53939	.34625	.54199	.34833	38
23	.53157	.34007	.53421	.34214	.53683	.34421	.53944	.34629	.54203	.34836	37
+ 6′	9.53162	.34011	9.53425	.34218	9.53687	.34425	9.53948	.34632	9.54208	.34840	36
25	.53166	.34014	.53429	.34221	.53691	.34428	.53952	.34636	.54212	.34843	35
26	.53170	.34018	.53434	.34224	.53696	.34432	.53957	.34639	.54216	.34847	34
27	.53175	.34021	.53438	.34228	.53700	.34435	.53961	.34643	.54221	.34850	33
+ 7′	9.53179	.34024	9.53442	.34231	9.53704	.34439	9.53966	.34646	9.54225	.34854	32
29	.53184	.34028	.53447	.34235	.53709	.34442	.53970	.34649	.54229	.34857	31
30	.53188	.34031	.53451	.34238	.53713	.34445	.53974	.34653	.54234	.34861	30
31	.53192	.34035	.53456	.34242	.53718	.34449	.53978	.34656	.54238	.34864	29
+ 8′	9.53197	.34038	9.53460	.34245	9.53722	.34452	9.53983	.34660	9.54242	.34868	28
33	.53201	.34042	.53464	.34249	.53726	.34456	.53987	.34663	.54247	.34871	27
34	.53206	.34045	.53469	.34252	.53731	.34459	.53991	.34667	.54251	.34875	26
35	.53210	.34049	.53473	.34256	.53735	.34463	.53996	.34670	.54255	.34878	25
+ 9′	9.53214	.34052	9.53477	.34259	9.53739	.34466	9.54000	.34674	9.54260	.34882	24
37	.53219	.34055	.53482	.34262	.53744	.34470	.54004	.34677	.54264	.34885	23
38	.53223	.34059	.53486	.34266	.53748	.34473	.54009	.34681	.54268	.34888	22
39	.53228	.34062	.53491	.34269	.53752	.34477	.54013	.34684	.54272	.34892	21
+ 10′	9.53232	.34066	9.53495	.34273	9.53757	.34480	9.54017	.34688	9.54277	.34895	20
41	.53236	.34069	.53499	.34276	.53761	.34483	.54022	.34691	.54281	.34899	19
42	.53241	.34073	.53504	.34280	.53765	.34487	.54026	.34694	.54285	.34902	18
43	.53245	.34076	.53508	.34283	.53770	.34490	.54030	.34698	.54290	.34906	17
+ 11′	9.53249	.34080	9.53512	.34287	9.53774	.34494	9.54035	.34701	9.54294	.34909	16
45	.53254	.34083	.53517	.34290	.53778	.34497	.54039	.34705	.54298	.34913	15
46	.53258	.34087	.53521	.34293	.53783	.34501	.54043	.34708	.54303	.34916	14
47	.53263	.34090	.53526	.34297	.53787	.34504	.54048	.34712	.54307	.34920	13
+ 12′	9.53267	.34093	9.53530	.34300	9.53792	.34508	9.54052	.34715	9.54311	.34923	12
49	.53271	.34097	.53534	.34304	.53796	.34511	.54056	.34719	.54316	.34927	11
50	.53276	.34100	.53539	.34307	.53800	.34515	.54061	.34722	.54320	.34930	10
51	.53280	.34104	.53543	.34311	.53805	.34518	.54065	.34726	.54324	.34933	9
+ 13′	9.53285	.34107	9.53547	.34314	9.53809	.34521	9.54069	.34729	9.54329	.34937	8
53	.53289	.34111	.53552	.34318	.53813	.34525	.54074	.34733	.54333	.34940	7
54	.53293	.34114	.53556	.34321	.53818	.34528	.54078	.34736	.54337	.34944	6
55	.53298	.34118	.53560	.34325	.53822	.34532	.54082	.34739	.54341	.34947	5
+ 14′	9.53302	.34121	9.53565	.34328	9.53826	.34535	9.54087	.34743	9.54346	.34951	4
57	.53307	.34124	.53569	.34331	.53831	.34539	.54091	.34746	.54350	.34954	3
58	.53311	.34128	.53574	.34335	.53835	.34542	.54095	.34750	.54354	.34958	2
59	.53315	.34131	.53578	.34338	.53839	.34546	.54100	.34753	.54359	.34961	1
+ 15′	9.53320	.34135	9.53582	.34342	9.53844	.34549	9.54104	.34757	9.54363	.34965	0
	$19^h 14^m$		$19^h 13^m$		$19^h 12^m$		$19^h 11^m$		$19^h 10^m$		

TABLE 45.

Haversines.

	$4^h\ 50^m$ 72° 30′		$4^h\ 51^m$ 72° 45′		$4^h\ 52^m$ 73° 0′	
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.
0	9.54363	.34965	9.54621	.35173	9.54878	.35381
1	.54367	.34968	.54625	.35176	.54882	.35385
2	.54372	.34972	.54629	.35180	.54886	.35388
3	.54376	.34975	.54634	.35183	.54890	.35392
+ 1′	9.54380	.34979	9.54638	.35187	9.54895	.35395
5	.54385	.34982	.54642	.35190	.54899	.35399
6	.54389	.34986	.54647	.35194	.54903	.35402
7	.54393	.34989	.54651	.35197	.54907	.35406
+ 2′	9.54397	.34992	9.54655	.35201	9.54912	.35409
9	.54402	.34996	.54659	.35204	.54916	.35413
10	.54406	.34999	.54664	.35208	.54920	.35416
11	.54410	.35003	.54668	.35211	.54924	.35420
+ 3′	9.54415	.35006	9.54672	.35215	9.54929	.35423
13	.54419	.35010	.54677	.35218	.54933	.35427
14	.54423	.35013	.54681	.35222	.54937	.35430
15	.54428	.35017	.54685	.35225	.54942	.35434
+ 4′	9.54432	.35020	9.54689	.35228	9.54946	.35437
17	.54436	.35024	.54694	.35232	.54950	.35441
18	.54440	.35027	.54698	.35235	.54954	.35444
19	.54445	.35031	.54702	.35239	.54959	.35448
+ 5′	9.54449	.35034	9.54707	.35242	9.54963	.35451
21	.54453	.35038	.54711	.35246	.54967	.35454
22	.54458	.35041	.54715	.35249	.54971	.35458
23	.54462	.35044	.54719	.35253	.54976	.35461
+ 6′	9.54466	.35048	9.54724	.35256	9.54980	.35465
25	.54471	.35051	.54728	.35260	.54984	.35468
26	.54475	.35055	.54732	.35263	.54988	.35472
27	.54479	.35058	.54736	.35267	.54993	.35475
+ 7′	9.54483	.35062	9.54741	.35270	9.54997	.35479
29	.54488	.35065	.54745	.35274	.55001	.35482
30	.54492	.35069	.54749	.35277	.55005	.35486
31	.54496	.35072	.54754	.35281	.55010	.35489
+ 8′	9.54501	.35076	9.54758	.35284	9.55014	.35493
33	.54505	.35079	.54762	.35288	.55018	.35496
34	.54509	.35083	.54766	.35291	.55022	.35500
35	.54514	.35086	.54771	.35294	.55027	.35503
+ 9′	9.54518	.35090	9.54775	.35298	9.55031	.35507
37	.54522	.35093	.54779	.35301	.55035	.35510
38	.54526	.35097	.54784	.35305	.55039	.35514
39	.54531	.35100	.54788	.35308	.55044	.35517
+ 10′	9.54535	.35103	9.54792	.35312	9.55048	.35521
41	.54539	.35107	.54796	.35315	.55052	.35524
42	.54544	.35110	.54801	.35319	.55057	.35528
43	.54548	.35114	.54805	.35322	.55061	.35531
+ 11′	9.54552	.35117	9.54809	.35326	9.55065	.35534
45	.54556	.35121	.54813	.35329	.55069	.35538
46	.54561	.35124	.54818	.35333	.55074	.35541
47	.54565	.35128	.54822	.35336	.55078	.35545
+ 12′	9.54569	.35131	9.54826	.35340	9.55082	.35548
49	.54574	.35135	.54831	.35343	.55086	.35552
50	.54578	.35138	.54835	.35347	.55091	.35555
51	.54582	.35142	.54839	.35350	.55095	.35559
+ 13′	9.54587	.35145	9.54843	.35354	9.55099	.35562
53	.54591	.35149	.54848	.35357	.55103	.35566
54	.54595	.35152	.54852	.35361	.55108	.35569
55	.54599	.35156	.54856	.35364	.55112	.35573
+ 14′	9.54604	.35159	9.54860	.35368	9.55116	.35576
57	.54608	.35162	.54865	.35371	.55120	.35580
58	.54612	.35166	.54869	.35374	.55125	.35583
59	.54617	.35169	.54873	.35378	.55129	.35587
+ 15′	9.54621	.35173	9.54878	.35381	9.55133	.35590
	$19^h\ 9^m$		$19^h\ 8^m$		$19^h\ 7^m$	

TABLE 45.

Haversines.

	$4^{h}\ 55^{m}$ 73° 45′		$4^{h}\ 56^{m}$ 74° 0′		$4^{h}\ 57^{m}$ 74° 15′		$4^{h}\ 58^{m}$ 74° 30′		$4^{h}\ 59^{m}$ 74° 45′		
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	s
0	9.55641	.36009	9.55893	.36218	9.56144	.36428	9.56393	.36638	9.56642	.36848	60
1	.55645	.36012	.55897	.36222	.56148	.36431	.56397	.36642	.56646	.36852	59
2	.55649	.36016	.55901	.36225	.56152	.36435	.56402	.36645	.56650	.36855	58
3	.55653	.36019	.55905	.36229	.56156	.36438	.56406	.36649	.56654	.36859	57
+ 1′	9.55657	.36023	9.55909	.36232	9.56160	.36442	9.56410	.36652	9.56658	.36862	56
5	.55662	.36026	.55914	.36236	.56164	.36445	.56414	.36656	.56663	.36866	55
6	.55666	.36030	.55918	.36239	.56169	.36449	.56418	.36659	.56667	.36869	54
7	.55670	.36033	.55922	.36243	.56173	.36452	.56422	.36663	.56671	.36873	53
+ 2′	9.55674	.36036	9.55926	.36246	9.56177	.36456	9.56426	.36666	9.56675	.36877	52
9	.55678	.36040	.55930	.36250	.56181	.36459	.56431	.36670	.56679	.36880	51
10	.55683	.36043	.55935	.36253	.56185	.36463	.56435	.36673	.56683	.36884	50
11	.55687	.36047	.55939	.36257	.56189	.36466	.56439	.36677	.56687	.36887	49
+ 3′	9.55691	.36050	9.55943	.36260	9.56194	.36470	9.56443	.36680	9.56692	.36891	48
13	.55695	.36054	.55947	.36264	.56198	.36473	.56447	.36684	.56696	.36894	47
− 14	.55699	.36057	.55951	.36267	.56202	.36477	.56451	.36687	.56700	.36898	46
15	.55704	.36061	.55955	.36271	.56206	.36480	.56456	.36691	.56704	.36901	45
+ 4′	9.55708	.36064	9.55960	.36274	9.56210	.36484	9.56460	.36694	9.56708	.36905	44
17	.55712	.36068	.55964	.36278	.56214	.36487	.56464	.36698	.56712	.36908	43
18	.55716	.36071	.55968	.36281	.56219	.36491	.56468	.36701	.56716	.36912	42
19	.55721	.36075	.55972	.36285	.56223	.36494	.56472	.36705	.56720	.36915	41
+ 5′	9.55725	.36078	9.55976	.36288	9.56227	.36498	9.56476	.36708	9.56725	.36919	40
21	.55729	.36082	.55981	.36292	.56231	.36501	.56480	.36712	.56729	.36922	39
22	.55733	.36085	.55985	.36225	.56235	.36505	.56485	.36715	.56733	.36926	38
23	.55737	.36089	.55989	.36299	.56239	.36508	.56489	.36719	.56737	.36929	37
+ 6′	9.55742	.36092	9.55993	.36302	9.56244	.36512	9.56493	.36722	9.56741	.36933	36
25	.55746	.36096	.55997	.36306	.56248	.36515	.56497	.36726	.56745	.36936	35
26	.55750	.36099	.56001	.36309	.56252	.36519	.56501	.36729	.56749	.36940	34
27	.55754	.36103	.56006	.36313	.56256	.36522	.56505	.36733	.56753	.36943	33
+ 7′	9.55758	.36106	9.56010	.36316	9.56260	.36526	9.56509	.36736	9.56758	.36947	32
29	.55763	.36110	.56014	.36320	.56264	.36529	.56514	.36740	.56762	.36950	31
30	.55767	.36113	.56018	.36323	.56269	.36533	.56518	.36743	.56766	.36954	30
31	.55771	.36117	.56022	.36327	.56273	.36536	.56522	.36747	.56770	.36957	29
+ 8′	9.55775	.36120	9.56027	.36330	9.56277	.36540	9.56526	.36750	9.56774	.36961	28
33	.55779	.36124	.56031	.36334	.56281	.36543	.56530	.36754	.56778	.36964	27
34	.55784	.36127	.56035	.36337	.56285	.36547	.56534	.36757	.56782	.36968	26
35	.55788	.36131	.56039	.36341	.56289	.36551	.56538	.36701	.56786	.36971	25
+ 9′	9.55792	.36134	9.56043	.36344	9.56294	.36554	9.56543	.36764	9.56791	.36975	24
37	.55796	.36138	.56047	.36348	.56298	.36558	.56547	.36768	.56795	.36978	23
38	.55800	.36141	.56052	.36351	.56302	.36561	.56551	.36771	.56799	.36982	22
39	.55805	.36145	.56056	.36355	.56306	.36565	.56555	.36775	.56803	.36985	21
+ 10′	9.55809	.36148	9.56060	.36358	9.56310	.36568	9.56559	.36778	9.56807	.36989	20
41	.55813	.36152	.56064	.36362	.56314	.36572	.56563	.36782	.56811	.36992	19
42	.55817	.36155	.56068	.36365	.56318	.36575	.56567	.36785	.56815	.36996	18
43	.55821	.36159	.56073	.36368	.56323	.36579	.56572	.36789	.56819	.36999	17
+ 11′	9.55826	.36162	9.56077	.36372	9.56327	.36582	9.56576	.36792	9.56824	.37003	16
45	.55830	.36166	.56081	.36376	.56331	.36586	.56580	.36796	.56828	.37006	15
46	.55834	.36169	.56085	.36379	.56335	.36589	.56584	.36799	.56832	.37010	14
47	.55838	.36173	.56089	.36382	.56339	.36593	.56588	.36803	.56836	.37013	13
+ 12′	9.55842	.36176	9.56093	.36386	9.56343	.36596	9.56592	.36806	9.56840	.37017	12
49	.55846	.36180	.56098	.36389	.56348	.36600	.56596	.36810	.56844	.37020	11
50	.55851	.36183	.56102	.36393	.56352	.36603	.56601	.36813	.56848	.37024	10
51	.55855	.36187	.56106	.36396	.56356	.36607	.56605	.36817	.56852	.37027	9
+ 13′	9.55859	.36190	9.56110	.36400	9.56360	.36610	9.56609	.36820	9.56856	.37031	8
53	.55863	.36194	.56114	.36403	.56364	.36614	.56613	.36824	.56861	.37034	7
54	.55867	.36197	.56118	.36407	.56368	.36617	.56617	.36827	.56865	.37038	6
55	.55872	.36201	.56123	.36410	.56373	.36621	.56621	.36831	.56869	.37041	5
+ 14′	9.55876	.36204	9.56127	.36414	9.56377	.36624	9.56625	.36834	9.56873	.37045	4
57	.55880	.36208	.56131	.36417	.56381	.36628	.56630	.36838	.56877	.37049	3
58	.55884	.36211	.56135	.36421	.56385	.36631	.56634	.36841	.56881	.37052	2
59	.55888	.36215	.56139	.36424	.56389	.36635	.56638	.36845	.56885	.37055	1
+ 15′	9.55893	.36218	9.56144	.36428	9.56393	.36638	9.56642	.36848	9.56889	.37059	0
	$19^{h}\ 4^{m}$		$19^{h}\ 3^{m}$		$19^{h}\ 2^{m}$		$19^{h}\ 1^{m}$		$19^{h}\ 0^{m}$		

TABLE 45.

Haversines.

	$5^h\ 0^m$ 75° 0′		$5^h\ 1^m$ 75° 15′		$5^h\ 2^m$ 75° 30′	
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.
0	9.56889	.37059	9.57136	.37270	9.57381	.37481
1	.56893	.37063	.57140	.37273	.57385	.37485
2	.56898	.37066	.57144	.37277	.57389	.37488
3	.56902	.37070	.57148	.37280	.57393	.37492
+ 1′	9.56906	.37073	9.57152	.37284	9.57397	.37495
5	.56910	.37077	.57156	.37287	.57402	.37499
6	.56914	.37080	.57160	.37291	.57406	.37502
7	.56918	.37084	.57165	.37295	.57410	.37506
+ 2′	9.56922	.37087	9.57169	.37298	9.57414	.37509
9	.56926	.37091	.57173	.37302	.57418	.37513
10	.56931	.37094	.57177	.37305	.57422	.37516
11	.56935	.37098	.57181	.37309	.57426	.37520
+ 3′	9.56939	.37101	9.57185	.37312	9.57430	.37523
13	.56943	.37105	.57189	.37316	.57434	.37527
14	.56947	.37108	.57193	.37319	.57438	.37530
15	.56951	.37112	.57197	.37323	.57442	.37534
+ 4′	9.56955	.37115	9.57201	.37326	9.57446	.37537
17	.56959	.37119	.57205	.37330	.57450	.37541
18	.56963	.37122	.57210	.37333	.57454	.37544
19	.56968	.37126	.57214	.37337	.57459	.37548
+ 5′	9.56972	.37129	9.57218	.37340	9.57463	.37551
21	.56976	.37133	.57222	.37344	.57467	.37555
22	.56980	.37136	.57226	.37347	.57471	.37558
23	.56984	.37140	.57230	.37351	.57475	.37562
+ 6′	9.56988	.37143	9.57234	.37354	9.57479	.37566
25	.56992	.37147	.57238	.37358	.57483	.37569
26	.56996	.37150	.57242	.37361	.57487	.37573
27	.57000	.37154	.57246	.37365	.57491	.37576
+ 7′	9.57005	.37157	9.57250	.37368	9.57495	.37580
29	.57009	.37161	.57255	.37372	.57499	.37583
30	.57013	.37164	.57259	.37375	.57503	.37587
31	.57017	.37168	.57263	.37379	.57507	.37590
+ 8′	9.57021	.37171	9.57267	.37382	9.57511	.37594
33	.57025	.37175	.57271	.37386	.57516	.37597
34	.57029	.37179	.57275	.37389	.57520	.37601
35	.57033	.37182	.57279	.37393	.57524	.37604
+ 9′	9.57037	.37186	9.57283	.37397	9.57528	.37608
37	.57042	.37189	.57287	.37400	.57532	.37611
38	.57046	.37193	.57291	.37404	.57536	.37615
39	.57050	.37196	.57295	.37407	.57540	.37618
+ 10′	9.57054	.37200	9.57299	.37411	9.57544	.37622
41	.57058	.37203	.57304	.37414	.57548	.37625
42	.57062	.37207	.57308	.37418	.57552	.37629
43	.57066	.37210	.57312	.37421	.57556	.37632
+ 11′	9.57070	.37214	9.57316	.37425	9.57560	.37636
45	.57074	.37217	.57320	.37428	.57564	.37639
46	.57078	.37221	.57324	.37432	.57568	.37643
47	.57083	.37224	.57328	.37435	.57572	.37647
+ 12′	9.57087	.37228	9.57332	.37439	9.57577	.37650
49	.57091	.37231	.57336	.37442	.57581	.37654
50	.57095	.37235	.57340	.37446	.57585	.37657
51	.57099	.37238	.57344	.37449	.57589	.37661
+ 13′	9.57103	.37242	9.57348	.37453	9.57593	.37664
53	.57107	.37245	.57353	.37456	.57597	.37668
54	.57111	.37249	.57357	.37460	.57601	.37671
55	.57115	.37252	.57361	.37463	.57605	.37675
+ 14′	9.57119	.37256	9.57365	.37467	9.57609	.37678
57	.57124	.37259	.57369	.37470	.57613	.37682
58	.57128	.37263	.57373	.37474	.57617	.37685
59	.57132	.37266	.57377	.37477	.57621	.37689
+ 15′	9.57136	.37270	9.57381	.37481	9.57625	.37692
	$18^h\ 59^m$		$18^h\ 58^m$		$18^h\ 57^m$	

TABLE 45.

Haversines.

s	$5^h\ 5^m$ 76° 15′		$5^h\ 6^m$ 76° 30′		$5^h\ 7^m$ 76° 45′		$5^h\ 8^m$ 77° 0′		$5^h\ 9^m$ 77° 15′		s
	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	
0	9.58110	.38116	9.58351	.38328	9.58591	.38540	9.58830	.38752	9.59068	.38965	60
1	.58114	.38119	.58355	.38331	.58595	.38544	.58834	.38756	.59072	.38969	59
2	.58118	.38123	.58359	.38335	.58599	.38547	.58838	.38760	.59076	.38972	58
3	.58122	.38126	.58363	.38338	.58603	.38551	.58842	.38763	.59079	.38976	57
+ 1′	9.58126	.38130	9.58367	.38342	9.58607	.38554	9.58846	.38767	9.59083	.38979	56
5	.58131	.38133	.58371	.38345	.58611	.38558	.58850	.38770	.59087	.38983	55
6	.58135	.38137	.58375	.38349	.58615	.38561	.58854	.38774	.59091	.38986	54
7	.58139	.38140	.58379	.38352	.58619	.38565	.58858	.38777	.59095	.38990	53
+ 2′	9.58143	.38144	9.58383	.38356	9.58623	.38568	9.58862	.38781	9.59099	.38994	52
9	.58147	.38148	.58387	.38360	.58627	.38572	.58866	.38784	.59103	.38997	51
10	.58151	.38151	.58391	.38363	.58631	.38575	.58870	.38788	.59107	.39001	50
11	.58155	.38155	.58395	.38367	.58635	.38579	.58874	.38791	.59111	.39004	49
+ 3′	9.58159	.38158	9.58399	.38370	9.58639	.38582	9.58878	.38795	9.59115	.39008	48
13	.58163	.38162	.58403	.38374	.58643	.38586	.58882	.38799	.59119	.39011	47
14	.58167	.38165	.58407	.38377	.58647	.38590	.58885	.38802	.59123	.39015	46
15	.58171	.38169	.58411	.38381	.58651	.38593	.58889	.38806	.59127	.39018	45
+ 4′	9.58175	.38172	9.58415	.38384	9.58655	.38597	9.58893	.38809	9.59131	.39022	44
17	.58179	.38176	.58419	.38388	.58659	.38600	.58897	.38813	.59135	.39025	43
18	.58183	.38179	.58423	.38391	.58663	.38604	.58901	.38816	.59139	.39029	42
19	.58187	.38183	.58427	.38395	.58667	.38607	.58905	.38820	.59143	.39033	41
+ 5′	9.58191	.38186	9.58431	.38398	9.58671	.38611	9.58909	.38823	9.59147	.39036	40
21	.58195	.38190	.58435	.38402	.58675	.38614	.58913	.38827	.59151	.39040	39
22	.58199	.38193	.58439	.38406	.58679	.38618	.58917	.38830	.59155	.39043	38
23	.58203	.38197	.58443	.38409	.58683	.38621	.58921	.38834	.59158	.39047	37
+ 6′	9.58207	.38200	9.58447	.38413	9.58687	.38625	9.58925	.38837	9.59162	.39050	36
25	.58211	.38204	.58451	.38416	.58691	.38628	.58929	.38841	.59166	.39054	35
26	.58215	.38208	.58455	.38420	.58695	.38632	.58933	.38845	.59170	.39057	34
27	.58219	.38211	.58459	.38423	.58699	.38636	.58937	.38848	.59174	.39061	33
+ 7′	9.58223	.38215	9.58463	.38427	9.58703	.38639	9.58941	.38852	9.59178	.39064	32
29	.58227	.38218	.58467	.38430	.58707	.38643	.58945	.38855	.59182	.39068	31
30	.58231	.38222	.58471	.38434	.58711	.38646	.58949	.38859	.59186	.39072	30
31	.58235	.38225	.58475	.38437	.58715	.38650	.58953	.38862	.59190	.39075	29
+ 8′	9.58239	.38229	9.58479	.38441	9.58719	.38653	9.58957	.38866	9.59194	.39079	28
33	.58243	.38232	.58483	.38444	.58723	.38657	.58961	.38869	.59198	.39082	27
34	.58247	.38236	.58487	.38448	.58727	.38660	.58965	.38873	.59202	.39086	26
35	.58251	.38239	.58491	.38451	.58731	.38664	.58969	.38876	.59206	.39089	25
+ 9′	9.58255	.38243	9.58495	.38455	9.58735	.38667	9.58973	.38880	9.59210	.39093	24
37	.58259	.38246	.58499	.38459	.58739	.38671	.58977	.38884	.59214	.39096	23
38	.58263	.38250	.58503	.38462	.58742	.38675	.58981	.38887	.59218	.39100	22
39	.58267	.38254	.58507	.38466	.58746	.38678	.58985	.38891	.59222	.39103	21
+ 10′	9.58271	.38257	9.58511	.38469	9.58750	.38682	9.58989	.38894	9.59225	.39107	20
41	.58275	.38261	.58515	.38473	.58754	.38685	.58992	.38898	.59229	.39111	19
42	.58279	.38264	.58519	.38476	.58758	.38689	.58996	.38901	.59233	.39114	18
43	.58283	.38268	.58523	.38480	.58762	.38692	.59000	.38905	.59237	.39118	17
+ 11′	9.58287	.38271	9.58527	.38483	9.58766	.38696	9.59004	.38908	9.59241	.39121	16
45	.58291	.38275	.58531	.38487	.58770	.38699	.59008	.38912	.59245	.39125	15
46	.58295	.38278	.58535	.38490	.58774	.38703	.59012	.38915	.59249	.39128	14
47	.58299	.38282	.58539	.38494	.58778	.38706	.59016	.38919	.59253	.39132	13
+ 12′	9.58303	.38285	9.58543	.38498	9.58782	.38710	9.59020	.38923	9.59257	.39135	12
49	.58307	.38289	.58547	.38501	.58786	.38713	.59024	.38926	.59261	.39139	11
50	.58311	.38292	.58551	.38505	.58790	.38717	.59028	.38930	.59265	.39143	10
51	.58315	.38296	.58555	.38508	.58794	.38721	.59032	.38933	.59269	.39146	9
+ 13′	9.58319	.38299	9.58559	.38512	9.58798	.38724	9.59036	.38937	9.59273	.39150	8
53	.58323	.38303	.58563	.38515	.58802	.38728	.59040	.38940	.59277	.39153	7
54	.58327	.38307	.58567	.38519	.58806	.38731	.59044	.38944	.59281	.39157	6
55	.58331	.38310	.58571	.38522	.58810	.38735	.59048	.38947	.59285	.39160	5
+ 14′	9.58335	.38314	9.58575	.38526	9.58814	.38738	9.59052	.38951	9.59289	.39164	4
57	.58339	.38317	.58579	.38529	.58818	.38742	.59056	.38954	.59292	.39167	3
58	.58343	.38321	.58583	.38533	.58822	.38745	.59060	.38958	.59296	.39171	2
59	.58347	.38324	.58587	.38536	.58826	.38749	.59064	.38962	.59300	.39174	1
+ 15′	9.58351	.38328	9.58591	.38540	9.58830	.38752	9.59068	.38965	9.59304	.39178	0
	$18^h\ 54^m$		$18^h\ 53^m$		$18^h\ 52^m$		$18^h\ 51^m$		$18^h\ 50^m$		

Haversines.

	$5^h\,10^m$ 77° 30′		$5^h\,11^m$ 77° 45′		$5^h\,12^m$ 78° 0′	
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Ha
0	9.59304	.39178	9.59540	.39391	9.59774	.39604
1	.59308	.39182	.59544	.39395	.59778	.39608
2	.59312	.39185	.59548	.39398	.59782	.39612
3	.59316	.39189	.59552	.39402	.59786	.39615
+ 1′	9.59320	.39192	9.59556	.39405	9.59790	.39619
5	.59324	.39196	.59559	.39409	.59794	.39622
6	.59328	.39199	.59563	.39412	.59798	.39626
7	.59332	.39203	.59567	.39416	.59802	.39629
+ 2′	9.59336	.39206	9.59571	.39420	9.59806	.39633
9	.59340	.39210	.59575	.39423	.59809	.39636
10	.59344	.39214	.59579	.39427	.59813	.39640
11	.59348	.39217	.59583	.39430	.59817	.39644
+ 3′	9.59351	.39221	9.59587	.39434	9.59821	.39647
13	.59355	.39224	.59591	.39437	.59825	.39651
14	.59359	.39228	.59595	.39441	.59829	.39654
15	.59363	.39231	.59599	.39444	.59833	.39658
+ 4′	9.59367	.39235	9.59602	.39448	9.59837	.39661
17	.59371	.39238	.59606	.39451	.59841	.39665
18	.59375	.39242	.59610	.39455	.59845	.39668
19	.59379	.39245	.59614	.39459	.59848	.39672
+ 5′	9.59383	.39249	9.59618	.39462	9.59852	.39676
21	.59387	.39253	.59622	.39466	.59856	.39679
22	.59391	.39256	.59626	.39469	.59860	.39683
23	.59395	.39260	.59630	.39473	.59864	.39686
+ 6′	9.59399	.39263	9.59634	.39476	9.59868	.39690
25	.59403	.39267	.59638	.39480	.59872	.39693
26	.59406	.39270	.59642	.39484	.59876	.39697
27	.59410	.39274	.59646	.39487	.59880	.39700
+ 7′	9.59414	.39277	9.59649	.39491	9.59883	.39704
29	.59418	.39281	.59653	.39494	.59887	.39708
30	.59422	.39285	.59657	.39498	.59891	.39711
31	.59426	.39288	.59661	.39501	.59895	.39715
+ 8′	9.59430	.39292	9.59665	.39505	9.59899	.39718
33	.59434	.39295	.59669	.39508	.59903	.39722
34	.59438	.39299	.59673	.39512	.59907	.39725
35	.59442	.39302	.59677	.39516	.59911	.39729
+ 9′	9.59446	.39306	9.59681	.39519	9.59915	.39732
37	.59450	.39309	.59685	.39523	.59918	.39736
38	.59454	.39313	.59688	.39526	.59922	.39739
39	.59458	.39317	.59692	.39530	.59926	.39743
+ 10′	9.59461	.39320	9.59696	.39533	9.59930	.39746
41	.59465	.39324	.59700	.39537	.59934	.39750
42	.59469	.39327	.59704	.39540	.59938	.39754
43	.59473	.39331	.59708	.39544	.59942	.39757
+ 11′	9.59477	.39334	9.59712	.39548	9.59946	.39761
45	.59481	.39338	.59716	.39551	.59950	.39765
46	.59485	.39341	.59720	.39555	.59953	.39768
47	.59489	.39345	.59724	.39558	.59957	.39772
+ 12′	9.59493	.39348	9.59728	.39562	9.59961	.39775
49	.59497	.39352	.59731	.39565	.59965	.39779
50	.59501	.39356	.59735	.39569	.59969	.39782
51	.59505	.39359	.59739	.39572	.59973	.39786
+ 13′	9.59508	.39363	9.59743	.39576	9.59977	.39789
53	.59512	.39366	.59747	.39580	.59981	.39793
54	.59516	.39370	.59751	.39583	.59985	.39796
55	.59520	.39373	.59755	.39587	.59988	.39800
+ 14′	9.59524	.39377	9.59759	.39590	9.59992	.39803
57	.59528	.39380	.59763	.39594	.59996	.39807
58	.59532	.39384	.59767	.39597	.60000	.39811
59	.59536	.39388	.59770	.39601	.60004	.39814
+ 15′	9.59540	.39391	9.59774	.39604	9.60008	.39818
	$18^h\,49^m$		$18^h\,48^m$		$18^h\,47^m$	

TABLE 45.

Haversines.

	$5^h\ 15^m$ 78° 45′		$5^h\ 16^m$ 79° 0′		$5^h\ 17^m$ 79° 15′		$5^h\ 18^m$ 79° 30′		$5^h\ 19^m$ 79° 45′		
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	s
0	9.60472	.40245	9.60702	.40460	9.60931	.40674	9.61160	.40888	9.61387	.41103	60
1	.60476	.40249	.60706	.40463	.60935	.40677	.61164	.40892	.61391	.41106	59
2	.60479	.40253	.60710	.40467	.60939	.40681	.61167	.40895	.61395	.41110	58
3	.60483	.40256	.60714	.40470	.60943	.40685	.61171	.40899	.61399	.41114	57
+ 1′	9.60487	.40260	9.60717	.40474	9.60947	.40688	9.61175	.40903	9.61402	.41117	56
5	.60491	.40263	.60721	.40477	.60951	.40692	.61179	.40906	.61406	.41121	55
6	.60495	.40267	.60725	.40481	.60954	.40695	.61183	.40910	.61410	.41124	54
7	.60499	.40270	.60729	.40485	.60958	.40699	.61186	.40913	.61414	.41128	53
+ 2′	9.60502	.40274	9.60733	.40488	9.60962	.40702	9.61190	.40917	9.61417	.41131	52
9	.60506	.40277	.60737	.40492	.60966	.40706	.61194	.40920	.61421	.41135	51
10	.60510	.40281	.60740	.40495	.60970	.40710	.61198	.40924	.61425	.41139	50
11	.60514	.40285	.60744	.40499	.60973	.40713	.61202	.40928	.61429	.41142	49
+ 3′	9.60518	.40288	9.60748	.40502	9.60977	.40717	9.61205	.40931	9.61433	.41146	48
13	.60522	.40292	.60752	.40506	.60981	.40720	.61209	.40935	.61436	.41149	47
14	.60526	.40295	.60756	.40510	.60985	.40724	.61213	.40938	.61440	.41153	46
15	.60529	.40299	.60760	.40513	.60989	.40727	.61217	.40942	.61444	.41156	45
+ 4′	9.60533	.40303	9.60763	.40517	9.60992	.40731	9.61221	.40945	9.61448	.41160	44
17	.60537	.40306	.60767	.40520	.60996	.40735	.61224	.40949	.61451	.41164	43
18	.60541	.40310	.60771	.40524	.61000	.40738	.61228	.40953	.61455	.41167	42
19	.60545	.40313	.60775	.40527	.61004	.40742	.61232	.40956	.61459	.41171	41
+ 5′	9.60549	.40317	9.60779	.40531	9.61008	.40745	9.61236	.40960	9.61463	.41174	40
21	.60552	.40320	.60783	.40535	.61012	.40749	.61240	.40963	.61467	.41178	39
22	.60556	.40324	.60786	.40538	.61015	.40752	.61243	.40967	.61470	.41182	38
23	.60560	.40328	.60790	.40542	.61019	.40756	.61247	.40970	.61474	.41185	37
+ 6′	9.60564	.40331	9.60794	.40545	9.61023	.40760	9.61251	.40974	9.61478	.41189	36
25	.60568	.40335	.60798	.40549	.61027	.40763	.61255	.40978	.61482	.41192	35
26	.60572	.40338	.60802	.40552	.61031	.40767	.61258	.40981	.61485	.41196	34
27	.60576	.40342	.60805	.40556	.61034	.40770	.61262	.40985	.61489	.41199	33
+ 7′	9.60579	.40345	9.60809	.40560	9.61038	.40774	9.61266	.40988	9.61493	.41203	32
29	.60583	.40349	.60813	.40563	.61042	.40777	.61270	.40992	.61497	.41207	31
30	.60587	.40352	.60817	.40567	.61046	.40781	.61274	.40996	.61500	.41210	30
31	.60591	.40356	.60821	.40570	.61050	.40785	.61277	.40999	.61504	.41214	29
+ 8′	9.60595	.40360	9.60825	.40574	9.61053	.40788	9.61281	.41003	9.61508	.41217	28
33	.60599	.40363	.60828	.40577	.61057	.40792	.61285	.41006	.61512	.41221	27
34	.60602	.40367	.60832	.40581	.61061	.40795	.61289	.41010	.61516	.41225	26
35	.60606	.40370	.60836	.40585	.61065	.40799	.61293	.41013	.61519	.41228	25
+ 9′	9.60610	.40374	9.60840	.40588	9.61069	.40802	9.61296	.41017	9.61523	.41232	24
37	.60614	.40377	.60844	.40592	.61072	.40806	.61300	.41021	.61527	.41235	23
38	.60618	.40381	.60847	.40595	.61076	.40810	.61304	.41024	.61531	.41239	22
39	.60622	.40385	.60851	.40599	.61080	.40813	.61308	.41028	.61534	.41242	21
+ 10′	9.60625	.40388	9.60855	.40602	9.61084	.40817	9.61312	.41031	9.61538	.41246	20
41	.60629	.40392	.60859	.40606	.61088	.40820	.61315	.41035	.61542	.41250	19
42	.60633	.40395	.60863	.40610	.61091	.40824	.61319	.41039	.61546	.41253	18
43	.60637	.40399	.60867	.40613	.61095	.40827	.61323	.41042	.61549	.41257	17
+ 11′	9.60641	.40402	9.60870	.40617	9.61099	.40831	9.61327	.41046	9.61553	.41260	16
45	.60645	.40406	.60874	.40620	.61103	.40835	.61330	.41049	.61557	.41264	15
46	.60648	.40410	.60878	.40624	.61107	.40838	.61334	.41053	.61561	.41267	14
47	.60652	.40413	.60882	.40627	.61110	.40842	.61338	.41056	.61565	.41271	13
+ 12′	9.60656	.40417	9.60886	.40631	9.61114	.40845	9.61342	.41060	9.61568	.41275	12
49	.60660	.40420	.60890	.40635	.61118	.40849	.61346	.41063	.61572	.41278	11
50	.60664	.40424	.60893	.40638	.61122	.40852	.61349	.41067	.61576	.41282	10
51	.60668	.40427	.60897	.40642	.61126	.40856	.61353	.41071	.61580	.41285	9
+ 13′	9.60671	.40431	9.60901	.40645	9.61129	.40860	9.61357	.41074	9.61583	.41289	8
53	.60675	.40434	.60905	.40649	.61133	.40863	.61361	.41078	.61587	.41293	7
54	.60679	.40438	.60909	.40652	.61137	.40867	.61364	.41082	.61591	.41296	6
55	.60683	.40442	.60912	.40656	.61141	.40870	.61368	.41085	.61595	.41300	5
+ 14′	9.60687	.40445	9.60916	.40660	9.61145	.40874	9.61372	.41089	9.61598	.41303	4
57	.60691	.40449	.60920	.40663	.61148	.40878	.61376	.41092	.61602	.41307	3
58	.60694	.40452	.60924	.40667	.61152	.40881	.61380	.41096	.61606	.41310	2
59	.60698	.40456	.60928	.40670	.61156	.40885	.61383	.41099	.61610	.41314	1
+ 15′	9.60702	.40460	9.60931	.40674	9.61160	.40888	9.61387	.41103	9.61614	.41318	0
	$18^h\ 44^m$		$18^h\ 43^m$		$18^h\ 42^m$		$18^h\ 41^m$		$18^h\ 40^m$		

TABLE 45.

Haversines.

	$5^{h}\ 20^{m}$ 80° 0′		$5^{h}\ 21^{m}$ 80° 15′		$5^{h}\ 22^{m}$ 80° 30′		$5^{h}\ 23^{m}$ 80° 45′		$5^{h}\ 24^{m}$ 81° 0′		
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	s
0	9.61614	.41318	9.61839	.41533	9.62063	.41748	9.62287	.41963	9.62509	.42178	60
1	.61617	.41321	.61843	.41536	.62067	.41751	.62290	.41966	.62513	.42182	59
2	.61621	.41325	.61846	.41540	.62071	.41755	.62294	.41970	.62516	.42185	58
3	.61625	.41328	.61850	.41543	.62074	.41758	.62298	.41974	.62520	.42189	57
+ 1′	9.61629	.41332	9.61854	.41547	9.62078	.41762	9.62301	.41977	9.62524	.42193	56
5	.61632	.41335	.61858	.41550	.62082	.41766	.62305	.41981	.62527	.42196	55
6	.61636	.41339	.61861	.41554	.62086	.41769	.62309	.41984	.62531	.42200	54
7	.61640	.41343	.61865	.41558	.62089	.41773	.62313	.41988	.62535	.42203	53
+ 2′	9.61644	.41346	9.61869	.41561	9.62093	.41776	9.62316	.41992	9.62538	.42207	52
9	.61647	.41350	.61873	.41565	.62097	.41780	.62320	.41995	.62542	.42211	51
10	.61651	.41353	.61876	.41568	.62100	.41783	.62324	.41999	.62546	.42214	50
11	.61655	.41357	.61880	.41572	.62104	.41787	.62327	.42002	.62550	.42218	49
+ 3′	9.61659	.41361	9.61884	.41576	9.62108	.41791	9.62331	.42006	9.62553	.42221	48
13	.61662	.41364	.61888	.41579	.62112	.41794	.62335	.42010	.62557	.42225	47
14	.61666	.41368	.61891	.41583	.62115	.41798	.62338	.42013	.62561	.42229	46
15	.61670	.41371	.61895	.41586	.62119	.41801	.62342	.42017	.62564	.42232	45
+ 4′	9.61674	.41375	9.61899	.41590	9.62123	.41805	9.62346	.42020	9.62568	.42236	44
17	.61677	.41378	.61903	.41593	.62127	.41809	.62350	.42024	.62572	.42239	43
18	.61681	.41382	.61906	.41597	.62130	.41812	.62353	.42027	.62575	.42243	42
19	.61685	.41386	.61910	.41601	.62134	.41816	.62357	.42031	.62579	.42247	41
+ 5′	9.61689	.41389	9.61914	.41604	9.62138	.41819	9.62361	.42035	9.62583	.42250	40
21	.61692	.41393	.61917	.41608	.62141	.41823	.62364	.42038	.62586	.42254	39
22	.61696	.41396	.61921	.41611	.62145	.41827	.62368	.42042	.62590	.42257	38
23	.61700	.41400	.61925	.41615	.62149	.41830	.62372	.42045	.62594	.42261	37
+ 6′	9.61704	.41404	9.61929	.41619	9.62153	.41834	9.62376	.42049	9.62598	.42264	36
25	.61708	.41407	.61932	.41622	.62156	.41837	.62379	.42053	.62601	.42268	35
26	.61711	.41411	.61936	.41626	.62160	.41841	.62383	.42056	.62605	.42272	34
27	.61715	.41414	.61940	.41629	.62164	.41844	.62387	.42060	.62609	.42275	33
+ 7′	9.61719	.41418	9.61944	.41633	9.62168	.41848	9.62390	.42063	9.62612	.42279	32
29	.61723	.41421	.61947	.41636	.62171	.41852	.62394	.42067	.62616	.42282	31
30	.61726	.41425	.61951	.41640	.62175	.41855	.62398	.42071	.62620	.42286	30
31	.61730	.41429	.61955	.41644	.62179	.41859	.62402	.42074	.62623	.42290	29
+ 8′	9.61734	.41432	9.61959	.41647	9.62182	.41862	9.62405	.42078	9.62627	.42293	28
33	.61738	.41436	.61962	.41651	.62186	.41866	.62409	.42081	.62631	.42297	27
34	.61741	.41439	.61966	.41654	.62190	.41870	.62413	.42085	.62634	.42300	26
35	.61745	.41443	.61970	.41658	.62194	.41873	.62416	.42089	.62638	.42304	25
+ 9′	9.61749	.41447	9.61974	.41662	9.62197	.41877	9.62420	.42092	9.62642	.42308	24
37	.61753	.41450	.61977	.41665	.62201	.41880	.62424	.42096	.62646	.42311	23
38	.61756	.41454	.61981	.41669	.62205	.41884	.62427	.42099	.62649	.42315	22
39	.61760	.41457	.61985	.41672	.62208	.41888	.62431	.42103	.62653	.42318	21
+ 10′	9.61764	.41461	9.61989	.41676	9.62212	.41891	9.62435	.42106	9.62657	.42322	20
41	.61768	.41464	.61992	.41679	.62216	.41895	.62439	.42110	.62660	.42326	19
42	.61771	.41468	.61996	.41683	.62220	.41898	.62442	.42114	.62664	.42329	18
43	.61775	.41472	.62000	.41687	.62223	.41902	.62446	.42117	.62668	.42333	17
+ 11′	9.61779	.41475	9.62003	.41690	9.62227	.41905	9.62450	.42121	9.62671	.42336	16
45	.61783	.41479	.62007	.41694	.62231	.41909	.62453	.42124	.62675	.42340	15
46	.61786	.41482	.62011	.41697	.62234	.41913	.62457	.42128	.62679	.42344	14
47	.61790	.41486	.62015	.41701	.62238	.41916	.62461	.42132	.62682	.42347	13
+ 12′	9.61794	.41490	9.62018	.41705	9.62242	.41920	9.62464	.42135	9.62686	.42351	12
49	.61798	.41493	.62022	.41708	.62246	.41923	.62468	.42139	.62690	.42354	11
50	.61801	.41497	.62026	.41712	.62249	.41927	.62472	.42142	.62693	.42358	10
51	.61805	.41500	.62030	.41715	.62253	.41931	.62476	.42146	.62697	.42361	9
+ 13′	9.61809	.41504	9.62033	.41719	9.62257	.41934	9.62479	.42150	9.62701	.42365	8
53	.61813	.41507	.62037	.41722	.62261	.41938	.62483	.42153	.62704	.42369	7
54	.61816	.41511	.62041	.41726	.62264	.41941	.62487	.42157	.62708	.42372	6
55	.61820	.41515	2045	.41730	.62268	.41945	.62490	.42160	.62712	.42376	5
+ 14′	9.61824	.41518	9.62048	.41733	9.62272	.41949	9.62494	.42164	9.62716	.42379	4
57	.61828	.41522	.62052	.41737	.62275	.41952	.62498	.42168	.62719	.42383	3
58	.61831	.41525	.62056	.41740	.62279	.41956	.62501	.42171	.62723	.42387	2
59	.61835	.41529	.62059	.41744	.62283	.41959	.62505	.42175	.62727	.42390	1
+ 15′	9.61839	.41533	9.62063	.41748	9.62287	.41963	9.62509	.42178	9.62730	.42394	0
	$18^{h}\ 39^{m}$		$18^{h}\ 38^{m}$		$18^{h}\ 37^{m}$		$18^{h}\ 36^{m}$		$18^{h}\ 35^{m}$		

TABLE 45.

Haversines.

	$5^{h}\,25^{m}$ 81° 15′		$5^{h}\,26^{m}$ 81° 30′		$5^{h}\,27^{m}$ 81° 45′		$5^{h}\,28^{m}$ 82° 0′		$5^{h}\,29^{m}$ 82° 15′		
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav	Nat. Hav.	s
0	9.62730	.42394	9.62951	.42610	9.63170	.42825	9.63389	.43041	9.63606	.43257	60
1	.62734	.42397	.62954	.42613	.63174	.42829	.63392	.43045	.63610	.43261	59
2	.62738	.42401	.62958	.42617	.63177	.42833	.63396	.43049	.63613	.43265	58
3	.62741	.42405	.62962	.42620	.63181	.42836	.63399	.43052	.63617	.43268	57
+ 1′	9.62745	.42408	9.62965	.42624	9.63185	.42840	9.63403	.43056	9.63621	.43272	56
5	.62749	.42412	.62969	.42628	.63188	.42843	.63407	.43059	.63624	.43275	55
6	.62752	.42415	.62973	.42631	.63192	.42847	.63410	.43063	.63628	.43279	54
7	.62756	.42419	.62976	.42635	.63196	.42851	.63414	.43067	.63631	.43283	53
+ 2′	9.62760	.42423	9.62980	.42638	9.63199	.42854	9.63418	.43070	9.63635	.43286	52
9	.62763	.42426	.62984	.42642	.63203	.42858	.63421	.43074	.63639	.43290	51
10	.62767	.42430	.62987	.42645	.63207	.42861	.63425	.43077	.63642	.43293	50
11	.62771	.42433	.62991	.42649	.63210	.42865	.63429	.43081	.63646	.43297	49
+ 3′	9.62774	.42437	9.62995	.42653	9.63214	.42869	9.63432	.43085	9.63649	.43301	48
13	.62778	.42441	.62998	.42656	.63218	.42872	.63436	.43088	.63653	.43304	47
14	.62782	.42444	.63002	.42660	.63221	.42876	.63439	.43092	.63657	.43308	46
15	.62785	.42448	.63006	.42663	.63225	.42879	.63443	.43095	.63660	.43312	45
+ 4′	9.62789	.42451	9.63009	.42667	9.63228	.42883	9.63447	.43099	9.63664	.43315	44
17	.62793	.42455	.63013	.42671	.63232	.42887	.63450	.43103	.63668	.43319	43
18	.62796	.42459	.63017	.42674	.63236	.42890	.63454	.43106	.63671	.43322	42
19	.62800	.42462	.63020	.42678	.63239	.42894	.63458	.43110	.63675	.43326	41
+ 5′	9.62804	.42466	9.63024	.42681	9.63243	.42897	9.63461	.43113	9.63678	.43330	40
21	.62808	.42469	.63028	.42685	.63247	.42901	.63465	.43117	.63682	.43333	39
22	.62811	.42473	.63031	.42689	.63250	.42905	.63468	.43121	.63686	.43337	38
23	.62815	.42477	.63035	.42692	.63254	.42908	.63472	.43124	.63689	.43340	37
+ 6′	9.62819	.42480	9.63039	.42696	9.63258	.42912	9.63476	.43128	9.63693	.43344	36
25	.62822	.42484	.63042	.42700	.63261	.42915	.63479	.43131	.63696	.43348	35
26	.62826	.42487	.63046	.42703	.63265	.42919	.63483	.43135	.63700	.43351	34
27	.62830	.42491	.63050	.42707	.63269	.42923	.63487	.43139	.63704	.43355	33
+ 7′	9.62833	.42494	9.63063	.42710	9.63272	.42926	9.63490	.43142	9.63707	.43358	32
29	.62837	.42498	.63057	.42714	.63276	.42930	.63494	.43146	.63711	.43362	31
30	.62841	.42502	.63061	.42717	.63279	.42933	.63497	.43149	.63714	.43366	30
31	.62844	.42505	.63064	.42721	.63283	.42937	.63501	.43153	.63718	.43369	29
+ 8′	9.62848	.42509	9.63068	.42725	9.63287	.42941	9.63505	.43157	9.63722	.43373	28
33	.62852	.42512	.63071	.42728	.63290	.42944	.63508	.43160	.63725	.43376	27
34	.62855	.42516	.63075	.42732	.63294	.42948	.63512	.43164	.63729	.43380	26
35	.62859	.42520	.63079	.42735	.63298	.42951	.63516	.43167	.63733	.43384	25
+ 9′	9.62863	.42523	9.63082	.42739	9.63301	.42955	9.63519	.43171	9.63736	.43387	24
37	.62866	.42527	.63086	.42743	.63305	.42959	.63523	.43175	.63740	.43391	23
38	.62870	.42530	.63090	.42746	.63309	.42962	.63526	.43178	.63743	.43394	22
39	.62874	.42534	.63093	.42750	.63312	.42966	.63530	.43182	.63747	.43398	21
+ 10′	9.62877	.42538	9.63097	.42753	9.63316	.42969	9.63534	.43185	9.63751	.43402	20
41	.62881	.42541	.63101	.42757	.63320	.42973	.63537	.43189	.63754	.43405	19
42	.62885	.42545	.63104	.42761	.63323	.42977	.63541	.43193	.63758	.43409	18
43	.62888	.42548	.63108	.42764	.63327	.42980	.63545	.43196	.63761	.43412	17
+ 11′	9.62892	.42552	9.63112	.42768	9.63330	.42984	9.63548	.43200	9.63765	.43416	16
45	.62896	.42556	.63115	.42771	.63334	.42987	.63552	.43203	.63769	.43420	15
46	.62899	.42559	.63119	.42775	.63338	.42991	.63555	.43207	.63772	.43423	14
47	.62903	.42563	.63123	.42779	.63341	.42995	.63559	.43211	.63776	.43427	13
+ 12′	9.62907	.42566	9.63126	.42782	9.63345	.42998	9.63563	.43214	9.63779	.43430	12
49	.62910	.42570	.63130	.42786	.63349	.43002	.63566	.43218	.63783	.43434	11
50	.62914	.42574	.63134	.42789	.63352	.43005	.63570	.43221	.63787	.43438	10
51	.62918	.42577	.63137	.42793	.63356	.43009	.63574	.43225	.63790	.43441	9
+ 13′	9.62921	.42581	9.63141	.42797	9.63360	.43013	9.63577	.43229	9.63794	.43445	8
53	.62925	.42584	.63145	.42800	.63363	.43016	.63581	.43232	.63797	.43448	7
54	.62929	.42588	.63148	.42804	.63367	.43020	.63584	.43236	.63801	.43452	6
55	.62932	.42592	.63152	.42807	.63370	.43023	.63588	.43239	.63805	.43456	5
+ 14′	9.62936	.42595	9.63156	.42811	9.63374	.43027	9.63592	.43243	9.63808	.43459	4
57	.62940	.42599	.63159	.42815	.63378	.43031	.63595	.43247	.63812	.43463	3
58	.62943	.42602	.63163	.42818	.63381	.43034	.63599	.43250	.63815	.43466	2
59	.62947	.42606	.63166	.42822	.63385	.43038	.63602	.43254	.63819	.43470	1
+ 15′	9.62951	.42610	9.63170	.42825	9.63389	.43041	9.63606	.43257	9.63823	.43474	0
	$18^{h}\,34^{m}$		$18^{h}\,33^{m}$		$18^{h}\,32^{m}$		$18^{h}\,31^{m}$		$18^{h}\,30^{m}$		

TABLE 45.

Haversines.

s	$5^h\,35^m$ 83° 45′		$5^h\,36^m$ 84° 0′		$5^h\,37^m$ 84° 15′		$5^h\,38^m$ 84° 30′		$5^h\,39^m$ 84° 45′		s
	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	
0	9.64891	.44557	9.65102	.44774	9.65312	.44991	9.65521	.45208	9.65729	.45425	60
1	.64895	.44560	.65106	.44777	.65316	.44994	.65525	.45211	.65733	.45429	59
2	.64898	.44564	.65109	.44781	.65319	.44998	.65528	.45215	.65736	.45432	58
3	.64902	.44568	.65113	.44784	.65323	.45001	.65532	.45219	.65740	.45436	57
+ 1′	9.64905	.44571	9.65116	.44788	9.65326	.45005	9.65535	.45222	9.65743	.45439	56
5	.64909	.44575	.65120	.44792	.65330	.45009	.65539	.45226	.65747	.45443	55
6	.64912	.44578	.65123	.44795	.65333	.45012	.65542	.45229	.65750	.45447	54
7	.64916	.44582	.65127	.44799	.65337	.45016	.65546	.45233	.65754	.45450	53
+ 2′	9.64919	.44586	9.65130	.44803	9.65340	.45020	9.65549	.45237	9.65757	.45454	52
9	.64923	.44589	.65134	.44806	.65344	.45023	.65553	.45240	.65761	.45458	51
10	.64926	.44593	.65137	.44810	.65347	.45027	.65556	.45244	.65764	.45461	50
11	.64930	.44596	.65141	.44813	.65351	.45030	.65559	.45248	.65767	.45465	49
+ 3′	9.64934	.44600	9.65144	.44817	9.65354	.45034	9.65563	.45251	9.65771	.45468	48
13	.64937	.44604	.65148	.44821	.65358	.45038	.65566	.45255	.65774	.45472	47
14	.64941	.44607	.65151	.44824	.65361	.45041	.65570	.45258	.65778	.45476	46
15	.64944	.44611	.65155	.44828	.65365	.45045	.65573	.45262	.65781	.45479	45
+ 4′	9.64948	.44614	9.65158	.44831	9.65368	.45045	9.65577	.45266	9.65785	.45483	44
17	.64951	.44618	.65162	.44835	.65372	.45052	.65580	.45269	.65788	.45483	43
18	.64955	.44622	.65165	.44839	.65375	.45056	.65584	.45273	.65792	.45490	42
19	.64958	.44625	.65169	.44842	.65378	.45059	.65587	.45276	.65795	.45494	41
+ 5′	9.64962	.44629	9.65172	.44846	9.65382	.45063	9.65591	.45280	9.65799	.45497	40
21	.64965	.44633	.65176	.44850	.65385	.45067	.65594	.45284	.65802	.45501	39
22	.64969	.44636	.65179	.44853	.65389	.45070	.65598	.45287	.65806	.45505	38
23	.64972	.44640	.65183	.44857	.65392	.45074	.65601	.45291	.65809	.45508	37
+ 6′	9.64976	.44643	9.65186	.44860	9.65396	.45077	9.65605	.45295	9.65812	.45512	36
25	.64979	.44647	.65190	.44864	.65399	.45081	.65608	.45298	.65816	.45515	35
26	.64983	.44651	.65193	.44868	.65403	.45085	.65612	.45302	.65819	.45519	34
27	.64986	.44654	.65197	.44871	.65406	.45085	.65615	.45305	.65823	.45523	33
+ 7′	9.64990	.44658	9.65200	.44875	9.65410	.45092	9.65619	.45305	9.65826	.45526	32
29	.64993	.44661	.65204	.44878	.65413	.45096	.65622	.45312	.65830	.45530	31
30	.64997	.44665	.65207	.44882	.65417	.45099	.65625	.45316	.65833	.45534	30
31	.65000	.44669	.65211	.44886	.65421	.45103	.65629	.45320	.65837	.45537	29
+ 8′	9.65004	.44672	9.65214	.44889	9.65424	.45106	9.65632	.45324	9.65840	.45541	28
33	.65007	.44676	.65218	.44893	.65427	.45110	.65636	.45327	.65844	.45544	27
34	.65011	.44680	.65221	.44897	.65431	.45114	.65639	.45331	.65847	.45548	26
35	.65014	.44683	.65225	.44900	.65434	.45117	.65643	.45334	.65850	.45552	25
+ 9′	9.65018	.44687	9.65228	.44904	9.65438	.45121	9.65646	.45338	9.65854	.45555	24
37	.65021	.44690	.65232	.44907	.65441	.45124	.65650	.45342	.65857	.45559	23
38	.65025	.44694	.65235	.44911	.65445	.45128	.65653	.45045	.65861	.45563	22
39	.65028	.44698	.65239	.44915	.65448	.45132	.65657	.45349	.65864	.45563	21
+ 10′	9.65032	.44701	9.65242	.44918	9.65452	.45135	9.65660	.45353	9.65868	.45570	20
41	.65035	.44705	.65246	.44922	.65455	.45139	.65664	.45353	.65871	.45573	19
42	.65039	.44708	.65249	.44925	.65459	.45143	.65667	.45360	.65875	.45577	18
43	.65043	.44712	.65253	.44929	.65462	.45146	.65671	.45363	.65878	.45581	17
+ 11′	9.65046	.44716	9.65256	.44933	9.65466	.45150	9.65674	.45367	9.65881	.45584	16
45	.65050	.44719	.65260	.44936	.65469	.45153	.65677	.45371	.65885	.45588	15
46	.65053	.44723	.65263	.44640	.65473	.45157	.65681	.45374	.65888	.45592	14
47	.65057	.44727	.65267	.44944	.65476	.45161	.65684	.45378	.65892	.45595	13
+ 12′	9.65060	.44730	9.65270	.44947	9.65480	.45164	9.65688	.45381	9.65895	.45599	12
49	.65064	.44734	.65274	.44951	.65483	.45168	.65691	.45385	.65899	.45602	11
50	.65067	.44737	.65277	.44954	.65486	.45172	.65695	.45389	.65902	.45606	10
51	.65071	.44741	.65281	.44958	.65490	.45175	.65698	.45392	.65906	.45610	9
+ 13′	9.65074	.44745	9.65284	.44962	9.65493	.45179	9.65702	.45396	9.65909	.45613	8
53	.65078	.44748	.65288	.44965	.65497	.45183	.65705	.45400	.65913	.45617	7
54	.65081	.44752	.65291	.44969	.65500	.45186	.65709	.45403	.65916	.45620	6
55	.65085	.44755	.65295	.44973	.65504	.45190	.65712	.45407	.65919	.45624	5
+ 14′	9.65088	.44759	9.65298	.44976	9.65507	.45193	9.65716	.45410	9.65923	.45628	4
57	.65092	.44763	.65302	.44980	.65511	.45197	.65719	.45414	.65926	.45631	3
58	.65095	.44766	.65305	.44983	.65514	.45200	.65722	.45418	.65930	.45635	2
59	.65099	.44770	.65309	.44987	.65518	.45204	.65726	.45421	.65933	.45639	1
+ 15′	9.65102	.44774	9.65312	.44991	9.65521	.45208	9.65729	.45425	9.65937	.45642	0
	$18^h\,24^m$		$18^h\,23^m$		$18^h\,22^m$		$18^h\,21^m$		$18^h\,20^m$		

Haversines.

	$5^h\ 40^m$ 85° 0′		$5^h\ 41^m$ 85° 15′		$5^h\ 42^m$ 85° 30′	
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav
0	9.65937	.45642	9.66143	.45860	9.66348	.46077
1	.65940	.45646	.66146	.45863	.66352	.46081
2	.65944	.45649	.66150	.45867	.66355	.46084
3	.65947	.45653	.66153	.45870	.66359	.46088
+ 1′	9.65950	.45657	9.66157	.45874	9.66362	.46092
5	.65954	.45660	.66160	.45878	.66366	.46095
6	.65957	.45664	.66164	.45881	.66369	.46099
7	.65961	.45668	.66167	.45885	.66372	.46102
+ 2′	9.65964	.45671	9.66170	.45889	9.66376	.46106
9	.65968	.45675	.66174	.45892	.66379	.46110
10	.65971	.45678	.66177	.45896	.66383	.46113
11	.65975	.45682	.66181	.45899	.66386	.46117
+ 3′	9.65978	.45686	9.66184	.45903	9.66389	.46121
13	.65981	.45689	.66188	.45907	.66393	.46124
14	.65985	.45693	.66191	.45910	.66396	.46128
15	.65988	.45697	.66194	.45914	.66400	.46131
+ 4′	9.65992	.45700	9.66198	.45918	9.66403	.46135
17	.65995	.45704	.66201	.45921	.66407	.46139
18	.65999	.45707	.66205	.45925	.66410	.46142
19	.66002	.45711	.66208	.45928	.66413	.46146
+ 5′	9.66006	.45715	9.66212	.45932	9.66417	.46150
21	.66009	.45718	.66215	.45936	.66420	.46153
22	.66012	.45722	.66218	.45939	.66424	.46157
23	.66016	.45726	.66222	.45943	.66427	.46161
+ 6′	9.66019	.45729	9.66225	.45947	9.66430	.46164
25	.66023	.45733	.66229	.45950	.66434	.46168
26	.66026	.45736	.66232	.45954	.66437	.46171
27	.66030	.45740	.66236	.45957	.66441	.46175
+ 7′	9.66033	.45744	9.66239	.45961	9.66444	.46179
29	.66037	.45747	.66242	.45965	.66447	.46182
30	.66040	.45751	.66246	.45968	.66451	.46186
31	.66043	.45755	.66249	.45972	.66454	.46189
+ 8′	9.66047	.45758	9.66253	.45976	9.66458	.46193
33	.66050	.45762	.66256	.45979	.66461	.46197
34	.66054	.45765	.66260	.45983	.66464	.46200
35	.66057	.45769	.66263	.45986	.66468	.46204
+ 9′	9.66061	.45773	9.66266	.45990	9.66471	.46208
37	.66064	.45776	.66270	.45994	.66475	.46211
38	.66067	.45780	.66273	.45997	.66478	.46215
39	.66071	.45783	.66277	.46001	.66482	.46218
+ 10′	9.66074	.45787	9.66280	.46005	9.66485	.46222
41	.66078	.45791	.66284	.46008	.66488	.46226
42	.66081	.45794	.66287	.46012	.66492	.46229
43	.66085	.45798	.66290	.46015	.66495	.46233
+ 11′	9.66088	.45802	9.66294	.46019	9.66499	.46237
45	.66092	.45805	.66297	.46023	.66502	.46240
46	.66095	.45809	.66301	.46026	.66505	.46244
47	.66098	.45812	.66304	.46030	.66509	.46247
+ 12′	9.66102	.45816	9.66307	.46034	9.66512	.46251
49	.66105	.45820	.66311	.46037	.66516	.46255
50	.66109	.45823	.66314	.46041	.66519	.46258
51	.66112	.45827	.66318	.46044	.66522	.46262
+ 13′	9.66116	.45831	9.66321	.46048	9.66526	.46266
53	.66119	.45834	.66325	.46052	.66529	.46269
54	.66122	.45838	.66328	.46055	.66533	.46273
55	.66126	.45841	.66331	.46059	.66536	.46276
+ 14′	9.66129	.45845	9.66335	.46063	9.66539	.46280
57	.66133	.45849	.66338	.46066	.66543	.46284
58	.66136	.45852	.66342	.46070	.66546	.46287
59	.66140	.45856	.66345	.46073	.66550	.46291
+ 15′	9.66143	.45860	9.66348	.46077	9.66553	.46295
	$18^h\ 19^m$		$18^h\ 18^m$		$18^h\ 17^m$	

TABLE 45.

Haversines.

s	$5^{h}\ 45^{m}$ 86° 15′		$5^{h}\ 46^{m}$ 86° 30′		$5^{h}\ 47^{m}$ 86° 45′		$5^{h}\ 48^{m}$ 87° 0′		$5^{h}\ 49^{m}$ 87° 15′		s
	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	
0	9.66959	.46730	9.67161	.46948	9.67362	.47165	9.67562	.47383	9.67762	.47601	60
1	.66963	.46733	.67165	.46951	.67366	.47169	.67566	.47387	.67765	.47605	59
2	.66966	.46737	.67168	.46955	.67369	.47173	.67569	.47390	.67768	.47608	58
3	.66970	.46741	.67171	.46958	.67372	.47176	.67572	.47394	.67772	.47612	57
+ 1′	9.66973	.46744	9.67175	.46962	9.67376	.47180	9.67576	.47398	9.67775	.47616	56
5	.66976	.46748	.67178	.46966	.67379	.47184	.67579	.47401	.67778	.47619	55
6	.66980	.46752	.67181	.46969	.67382	.47187	.67582	.47405	.67782	.47623	54
7	.66983	.46755	.67185	.46973	.67386	.47191	.67586	.47409	.67785	.47627	53
+ 2′	9.66986	.46759	9.67188	.46977	9.67389	.47194	9.67589	.47412	9.67788	.47630	52
9	.66990	.46762	.67192	.46980	.67392	.47198	.67592	.47416	.67792	.47634	51
10	.66993	.46766	.67195	.46984	.67396	.47202	.67596	.47420	.67795	.47637	50
11	.66997	.46770	.67198	.46987	.67399	.47205	.67599	.47423	.67798	.47641	49
+ 3′	9.67000	.46773	9.67202	.46991	9.67402	.47209	9.67602	.47427	9.67801	.47645	48
13	.67003	.46777	.67205	.46995	.67406	.47213	.67606	.47430	.67805	.47648	47
14	.67007	.46781	.67208	.46998	.67409	.47216	.67609	.47434	.67808	.47652	46
15	.67010	.46784	.67212	.47002	.67412	.47220	.67612	.47438	.67811	.47656	45
+ 4′	9.67013	.46788	9.67215	.47006	9.67416	.47223	9.67616	.47441	9.67815	.47659	44
17	.67017	.46792	.67218	.47009	.67419	.47227	.67619	.47445	.67818	.47663	43
18	.67020	.46795	.67222	.47013	.67422	.47231	.67622	.47449	.67821	.47666	42
19	.67023	.46799	.67225	.47017	.67426	.47234	.67626	.47452	.67825	.47670	41
+ 5′	9.67027	.46802	9.67228	.47020	9.67429	.47238	9.67629	.47456	9.67828	.47674	40
21	.67030	.46806	.67232	.47024	.67432	.47242	.67632	.47459	.67831	.47677	39
22	.67034	.46810	.67235	.47027	.67436	.47245	.67636	.47463	.67835	.47681	38
23	.67037	.46813	.67238	.47031	.67439	.47249	.67639	.47467	.67838	.47685	37
+ 6′	9.67040	.46817	9.67242	.47035	9.67443	.47252	9.67642	.47470	9.67841	.47688	36
25	.67044	.46821	.67245	.47038	.67446	.47256	.67646	.47474	.67844	.47692	35
26	.67047	.46824	.67249	.47042	.67449	.47260	.67649	.47478	.67848	.47696	34
27	.67050	.46828	.67252	.47046	.67452	.47263	.67652	.47481	.67851	.47699	33
+ 7′	9.67054	.46831	9.67255	.47049	9.67456	.47267	9.67656	.47485	9.67854	.47703	32
29	.67057	.46835	.67259	.47053	.67459	.47271	.67659	.47489	.67858	.47706	31
30	.67060	.46839	.67262	.47056	.67462	.47274	.67662	.47492	.67861	.47710	30
31	.67064	.46842	.67265	.47060	.67466	.47278	.67666	.47496	.67864	.47714	29
+ 8′	9.67067	.46846	9.67269	.47064	9.67469	.47282	9.67669	.47499	9.67868	.47717	28
33	.67071	.46850	.67272	.47067	.67472	.47285	.67672	.47503	.67871	.47721	27
34	.67074	.46853	.67275	.47071	.67476	.47289	.67675	.47507	.67874	.47725	26
35	.67077	.46857	.67279	.47075	.67479	.47292	.67679	.47510	.67878	.47728	25
+ 9′	9.67081	.46860	9.67282	.47078	9.67483	.47296	9.67682	.47514	9.67881	.47732	24
37	.67084	.46864	.67285	.47082	.67486	.47300	.67685	.47518	.67884	.47735	23
38	.67087	.46868	.67289	.47086	.67489	.47303	.67689	.47521	.67887	.47739	22
39	.67091	.46871	.67292	.47089	.67493	.47307	.67692	.47525	.67891	.47743	21
+ 10′	9.67094	.46875	9.67295	.47093	9.67496	.47311	9.67695	.47528	9.67894	.47746	20
41	.67097	.46879	.67299	.47096	.67499	.47314	.67699	.47532	.67897	.47750	19
42	.67101	.46882	.67302	.47100	.67503	.47318	.67702	.47536	.67901	.47754	18
43	.67104	.46886	.67305	.47104	.67506	.47321	.67705	.47539	.67904	.47757	17
+ 11′	9.67108	.46890	9.67309	.47107	9.67509	.47325	9.67709	.47543	9.67907	.47761	16
45	.67111	.46893	.67312	.47111	.67512	.47329	.67712	.47547	.67911	.47765	15
46	.67114	.46897	.67315	.47115	.67516	.47332	.67715	.47550	.67914	.47768	14
47	.67118	.46900	.67319	.47118	.67519	.47336	.67719	.47554	.67917	.47772	13
+ 12′	9.67121	.46904	9.67322	.47122	9.67522	.47340	9.67722	.47558	9.67920	.47775	12
49	.67124	.46908	.67326	.47125	.67526	.47343	.67725	.47561	.67924	.47779	11
50	.67128	.46911	.67329	.47129	.67529	.47347	.67729	.47565	.67927	.47783	10
51	.67131	.46915	.67332	.47123	.67532	.47351	.67732	.47568	.67930	.47786	9
+ 13′	9.67134	.46919	9.67336	.47136	9.67536	.47354	9.67735	.47572	9.67934	.47790	8
53	.67138	.46922	.67339	.47146	.67539	.47358	.67738	.47576	.67937	.47794	7
54	.67141	.46926	.67342	.47144	.67542	.47361	.67742	.47579	.67940	.47797	6
55	.67145	.46929	.67346	.47147	.67546	.47365	.67745	.47583	.67944	.47801	5
+ 14′	9.67148	.46933	9.67349	.47151	9.67549	.47369	9.67748	.47587	9.67947	.47805	4
57	.67151	.46937	.67352	.47155	.67552	.47372	.67752	.47590	.67950	.47808	3
58	.67155	.46940	.67356	.47158	.67556	.47376	.67755	.47594	.67953	.47812	2
59	.67158	.46944	.67359	.47162	.67559	.47380	.67758	.47597	.67957	.47815	1
+ 15′	9.67161	.46948	9.67362	.47165	9.67562	.47383	9.67762	.47601	9.67960	.47819	0
	$18^{h}\ 14^{m}$		$18^{h}\ 13^{m}$		$18^{h}\ 12^{m}$		$18^{h}\ 11^{m}$		$18^{h}\ 10^{m}$		

Haversines.

	$5^h\ 50^m$ 87° 30′		$5^h\ 51^m$ 87° 45′		$5^h\ 52^m$ 88° 0′	
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.
0	9.67960	.47819	9.68158	.48037	9.68354	.48255
1	.67963	.47823	.68161	.48041	.68358	.48259
2	.67967	.47826	.68164	.48044	.68361	.48262
3	.67970	.47830	.68167	.48048	.68364	.48266
+ 1′	9.67973	.47834	9.68171	.48052	9.68367	.48270
5	.67977	.47837	.68174	.48055	.68371	.48273
6	.67980	.47841	.68177	.48059	.68374	.48277
7	.67983	.47844	.68181	.48062	.68377	.48280
+ 2′	9.67986	.47848	9.68184	.48066	9.68380	.48284
9	.67990	.47852	.68187	.48070	.68384	.48288
10	.67993	.47855	.68190	.48073	.68387	.48291
11	.67996	.47859	.68194	.48077	.68390	.48295
+ 3′	9.68000	.47863	9.68197	.48081	9.68393	.48299
13	.68003	.47866	.68200	.48084	.68397	.48302
14	.68006	.47870	.68204	.48088	.68400	.48306
15	.68010	.47874	.68207	.48092	.68403	.48310
+ 4′	9.68013	.47877	9.68210	.48095	9.68407	.48313
17	.68016	.47881	.68213	.48099	.68410	.48317
18	.68019	.47884	.68217	.48102	.68413	.48320
19	.68023	.47888	.68220	.48106	.68416	.48324
+ 5′	9.68026	.47892	9.68223	.48110	9.68420	.48328
21	.68029	.47895	.68227	.48113	.68423	.48331
22	.68033	.47899	.68230	.48117	.68426	.48335
23	.68036	.47903	.68233	.48121	.68429	.48339
+ 6′	9.68039	.47906	9.68236	.48124	9.68433	.48342
25	.68042	.47910	.68240	.48128	.68436	.48346
26	.68046	.47913	.68243	.48131	.68439	.48350
27	.68049	.47917	.68246	.48135	.68442	.48353
+ 7′	9.68052	.47921	9.68249	.48139	9.68446	.48357
29	.68056	.47924	.68253	.48142	.68449	.48360
30	.68059	.47928	.68256	.48146	.68452	.48364
31	.68062	.47932	.68259	.48150	.68456	.48368
+ 8′	9.68066	.47935	9.68263	.48153	9.68459	.48371
33	.68069	.47939	.68266	.48157	.68462	.48375
34	.68072	.47943	.68269	.48161	.68465	.48379
35	.68075	.47946	.68272	.48164	.68469	.48382
+ 9′	9.68079	.47950	9.68276	.48168	9.68472	.48386
37	.68082	.47953	.68279	.48171	.68475	.48389
38	.68085	.47957	.68282	.48175	.68478	.48393
39	.68089	.47961	.68286	.48179	.68482	.48397
+ 10′	9.68092	.47964	9.68289	.48182	9.68485	.48400
41	.68095	.47968	.68292	.48186	.68488	.48404
42	.68098	.47972	.68295	.48190	.68491	.48408
43	.68102	.47975	.68299	.48193	.68495	.48411
+ 11′	9.68105	.47979	9.68302	.48197	9.68498	.48415
45	.68108	.47983	.68305	.48201	.68501	.48419
46	.68112	.47986	.68308	.48204	.68504	.48422
47	.68115	.47990	.68312	.48208	.68508	.48426
+ 12′	9.68118	.47993	9.68315	.48211	9.68511	.48429
49	.68121	.47997	.68318	.48215	.68514	.48433
50	.68125	.48001	.68322	.48219	.68517	.48437
51	.68128	.48004	.68325	.48222	.68521	.48440
+ 13′	9.68131	.48008	9.68328	.48226	9.68524	.48444
53	.68135	.48012	.68331	.48230	.68527	.48448
54	.68138	.48015	.68335	.48233	.68531	.48451
55	.68141	.48019	.68338	.48237	.68534	.48455
+ 14′	9.68144	.48022	9.68341	.48241	9.68537	.48459
57	.68148	.48026	.68344	.48244	.68540	.48462
58	.68151	.48030	.68348	.48248	.68544	.48466
59	.68154	.48033	.68351	.48251	.68547	.48469
+ 15′	9.68158	.48037	9.68354	.48255	9.68550	.48473
	$18^h\ 9^m$		$18^h\ 8^m$		$18^h\ 7^m$	

TABLE 45.

Haversines.

s	$5^h\,55^m$ 88° 45′		$5^h\,56^m$ 89° 0′		$5^h\,57^m$ 89° 15′		$5^h\,58^m$ 89° 30′		$5^h\,59^m$ 89° 45′		s
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	s
0	9.68939	.48909	9.69132	.49127	9.69325	.49346	9.69516	.49564	9.69707	.49782	60
1	.68942	.48913	.69136	.49131	.69328	.49349	.69520	.49567	.69710	.49785	59
2	.68946	.48917	.69139	.49135	.69331	.49353	.69523	.49571	.69713	.49789	58
3	.68949	.48920	.69142	.49138	.69334	.49356	.69526	.49575	.69717	.49793	57
+ 1′	9.68952	.48924	9.69145	.49142	9.69338	.49360	9.69529	.49578	9.69720	.49796	56
5	.68955	.48927	.69148	.49146	.69341	.49364	.69532	.49582	.69723	.49800	55
6	.68958	.48931	.69152	.49149	.69344	.49367	.69535	.49585	.69726	.49804	54
7	.68962	.48935	.69155	.49153	.69347	.49371	.69539	.49589	.69729	.49807	53
+ 2′	9.68965	.48938	9.69158	.49156	9.69350	.49375	9.69542	.49593	9.69732	.49811	52
9	.68968	.48942	.69161	.49160	.69354	.49378	.69545	.49596	.69736	.49815	51
10	.68971	.48946	.69164	.49164	.69357	.49382	.69548	.49600	.69739	.49818	50
11	.68975	.48949	.69168	.49167	.69360	.49386	.69551	.49604	.69742	.49822	49
+ 3′	9.68978	.48953	9.69171	.49171	9.69363	.49389	9.69555	.49607	9.69745	.49825	48
13	.68981	.48957	.69174	.49175	.69366	.49393	.69558	.49611	.69748	.49829	47
14	.68984	.48960	.69177	.49178	.69370	.49396	.69561	.49615	.69751	.49833	46
15	.68988	.48964	.69181	.49182	.69373	.49400	.69564	.49618	.69755	.49836	45
+ 4′	9.68991	.48967	9.69184	.49186	9.69376	.49404	9.69567	.49622	9.69758	.49840	44
17	.68994	.48971	.69187	.49189	.69379	.49407	.69570	.49625	.69761	.49844	43
18	.68997	.48975	.69190	.49193	.69382	.49411	.69574	.49629	.69764	.49847	42
19	.69000	.48978	.69193	.49196	.69386	.49415	.69577	.49633	.69767	.49851	41
+ 5′	9.69004	.48982	9.69197	.49200	9.69389	.49418	9.69580	.49636	9.69770	.49855	40
21	.69007	.48986	.69200	.49204	.69392	.49422	.69583	.49640	.69774	.49858	39
22	.69010	.48989	.69203	.49207	.69395	.49426	.69586	.49644	.69777	.49862	38
23	.69013	.48993	.69206	.49211	.69398	.49429	.69590	.49647	.69780	.49865	37
+ 6′	9.69017	.48997	9.69209	.49215	9.69402	.49433	9.69593	.49651	9.69783	.49869	36
25	.69020	.49000	.69213	.49218	.69405	.49436	.69596	.49655	.69786	.49873	35
26	.69023	.49004	.69216	.49222	.69408	.49440	.69599	.49658	.69789	.49876	34
27	.69026	.49007	.69219	.49226	.69411	.49444	.69602	.49662	.69793	.49880	33
+ 7′	9.69029	.49011	9.69222	.49229	9.69414	.49447	9.69605	.49665	9.69796	.49884	32
29	.69033	.49015	.69225	.49233	.69417	.49451	.69609	.49669	.69799	.49887	31
30	.69036	.49018	.69229	.49236	.69421	.49455	.69612	.49673	.69802	.49891	30
31	.69039	.49022	.69232	.49240	.69424	.49458	.69615	.49676	.69805	.49895	29
+ 8′	9.69042	.49026	9.69235	.49244	9.69427	.49462	9.69618	.49680	9.69808	.49898	28
33	.69046	.49029	.69238	.49247	.69430	.49466	.69621	.49684	.69812	.49902	27
34	.69049	.49033	.69242	.49251	.69433	.49469	.69625	.49687	.69815	.49905	26
35	.69052	.49036	.69245	.49255	.69437	.49473	.69628	.49691	.69818	.49909	25
+ 9′	9.69055	.49040	9.69248	.49258	9.69440	.49476	9.69631	.49695	9.69821	.49913	24
37	.69058	.49044	.69251	.49262	.69443	.49480	.69634	.49698	.69824	.49916	23
38	.69062	.49047	.69254	.49266	.69446	.49484	.69637	.49702	.69827	.49920	22
39	.69065	.49051	.69258	.49269	.69449	.49487	.69640	.49705	.69831	.49924	21
+ 10′	9.69068	.49055	9.69261	.49273	9.69453	.49491	9.69644	.49709	9.69834	.49927	20
41	.69071	.49058	.69264	.49276	.69456	.49495	.69647	.49713	.69837	.49931	19
42	.69074	.49062	.69267	.49280	.69459	.49498	.69650	.49716	.69840	.49935	18
43	.69078	.49066	.69270	.49284	.69462	.49502	.69653	.49720	.69843	.49938	17
+ 11′	9.69081	.49069	9.69274	.49287	9.69465	.49506	9.69656	.49724	9.69846	.49942	16
45	.69084	.49073	.69277	.49291	.69469	.49509	.69659	.49727	.69850	.49945	15
46	.69087	.49076	.69280	.49295	.69472	.49513	.69663	.49731	.69853	.49949	14
47	.69091	.49080	.69283	.49298	.69475	.49516	.69666	.49735	.69856	.49953	13
+ 12′	9.69094	.49084	9.69286	.49302	9.69478	.49520	9.69669	.49738	9.69859	.49956	12
49	.69097	.49087	.69290	.49306	.69481	.49524	.69672	.49742	.69862	.49960	11
50	.69100	.49091	.69293	.49309	.69484	.49527	.69675	.49745	.69865	.49964	10
51	.69103	.49095	.69296	.49313	.69488	.49531	.69678	.49749	.69869	.49967	9
+ 13′	9.69107	.49098	9.69299	.49316	9.69491	.49535	9.69682	.49753	9.69872	.49971	8
53	.69110	.49102	.69302	.49320	.69494	.49538	.69685	.49756	.69875	.49975	7
54	.69113	.49106	.69306	.49324	.69497	.49542	.69688	.49760	.69878	.49978	6
55	.69116	.49109	.69309	.49327	.69500	.49545	.69691	.49764	.69881	.49982	5
+ 14′	9.69120	.49113	9.69312	.49331	9.69504	.49549	9.69694	.49767	9.69884	.49985	4
57	.69123	.49116	.69315	.49335	.69507	.49553	.69698	.49771	.69888	.49989	3
58	.69126	.49120	.69318	.49338	.69510	.49556	.69701	.49775	.69891	.49993	2
59	.69129	.49124	.69322	.49342	.69513	.49560	.69704	.49778	.69894	.49996	1
+ 15′	9.69132	.49127	9.69325	.49346	9.69516	.49564	9.69707	.49782	9.69897	.50000	0
	$18^h\,4^m$		$18^h\,3^m$		$18^h\,2^m$		$18^h\,1^m$		$18^h\,0^m$		

Haversines.

	$6^h\ 0^m$ 90° 0′		$6^h\ 1^m$ 90° 15′		$6^h\ 2^m$ 90° 30′	
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.
0	9.69897	.50000	9.70086	.50218	9.70274	.50436
1	.69900	.50004	.70089	.50222	.70277	.50440
2	.69903	.50007	.70092	.50225	.70281	.50444
3	.69906	.50011	.70096	.50229	.70284	.50447
+ 1′	9.69910	.50015	9.70099	.50233	9.70287	.50451
5	.69913	.50018	.70102	.50236	.70290	.50455
6	.69916	.50022	.70105	.50240	.70293	.50458
7	.69919	.50025	.70108	.50244	.70296	.50462
+ 2′	9.69922	.50029	9.70111	.50247	9.70299	.50465
9	.69925	.50033	.70114	.50251	.70303	.50469
10	.69929	.50036	.70118	.50255	.70306	.50473
11	.69932	.50040	.70121	.50258	.70309	.50476
+ 3′	9.69935	.50044	9.70124	.50262	9.70312	.50480
13	.69938	.50047	.70127	.50265	.70315	.50484
14	.69941	.50051	.70130	.50269	.70318	.50487
15	.69944	.50055	.70133	.50273	.70321	.50491
+ 4′	9.69948	.50058	9.70136	.50276	9.70324	.50495
17	.69951	.50062	.70140	.50280	.70328	.50498
18	.69954	.50065	.70143	.50284	.70331	.50502
19	.69957	.50069	.70146	.50287	.70334	.50505
+ 5′	9.69960	.50073	9.70149	.50291	9.70337	.50509
21	.69963	.50076	.70152	.50295	.70340	.50513
22	.69966	.50080	.70155	.50298	.70343	.50516
23	.69970	.50084	.70158	.50302	.70346	.50520
+ 6′	9.69973	.50087	9.70161	.50305	9.70349	.50524
25	.69976	.50091	.70165	.50309	.70353	.50527
26	.69979	.50095	.70168	.50313	.70356	.50531
27	.69982	.50098	.70171	.50316	.70359	.50534
+ 7′	9.69985	.50102	9.70174	.50320	9.70362	.50538
29	.69988	.50105	.70177	.50324	.70365	.50542
30	.69992	.50109	.70180	.50327	.70368	.50545
31	.69995	.50113	.70183	.50331	.70371	.50549
+ 8′	9.69998	.50116	9.70187	.50335	9.70374	.50553
33	.70001	.50120	.70190	.50338	.70378	.50556
34	.70004	.50124	.70193	.50342	.70381	.50560
35	.70007	.50127	.70196	.50345	.70384	.50564
+ 9′	9.70011	.50131	9.70199	.50349	9.70387	.50567
37	.70014	.50135	.70202	.50353	.70390	.50571
38	.70017	.50138	.70205	.50356	.70393	.50574
39	.70020	.50142	.70209	.50360	.70396	.50578
+ 10′	9.70023	.50145	9.70212	.50364	9.70399	.50582
41	.70026	.50149	.70215	.50367	.70402	.50585
42	.70029	.50153	.70218	.50371	.70406	.50589
43	.70033	.50156	.70221	.50375	.70409	.50593
+ 11′	9.70036	.50160	9.70224	.50378	9.70412	.50596
45	.70039	.50164	.70227	.50382	.70415	.50600
46	.70042	.50167	.70230	.50385	.70418	.50604
47	.70045	.50171	.70234	.50389	.70421	.50607
+ 12′	9.70048	.50175	9.70237	.50393	9.70424	.50611
49	.70051	.50178	.70240	.50396	.70427	.50614
50	.70055	.50182	.70243	.50400	.70431	.50618
51	.70058	.50185	.70246	.50404	.70434	.50622
+ 13′	9.70061	.50189	9.70249	.50407	9.70437	.50625
53	.70064	.50193	.70252	.50411	.70440	.50629
54	.70067	.50196	.70256	.50415	.70443	.50633
55	.70070	.50200	.70259	.50418	.70446	.50636
+ 14′	9.70074	.50204	9.70262	.50422	9.70449	.50640
57	.70077	.50207	.70265	.50425	.70452	.50644
58	.70080	.50211	.70268	.50429	.70456	.50647
59	.70083	.50215	.70271	.50433	.70459	.50651
+ 15′	9.70086	.50218	9.70274	.50436	9.70462	.50654
	$17^h\ 59^m$		$17^h\ 58^m$		$17^h\ 57^m$	

TABLE 45.

Haversines.

	$6^h\ 5^m$ 91° 15′		$6^h\ 6^m$ 91° 30′		$6^h\ 7^m$ 91° 45′		$6^h\ 8^m$ 92° 0′		$6^h\ 9^m$ 92° 15′		
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	s
0	9.70834	.51091	9.71019	.51309	9.71203	.51527	9.71387	.51745	9.71569	.51963	60
1	.70837	.51094	.71022	.51312	.71206	.51531	.71390	.51749	.71572	.51967	59
2	.70840	.51098	.71025	.51316	.71210	.51534	.71393	.51752	.71575	.51970	58
3	.70843	.51102	.71028	.51320	.71213	.51538	.71396	.51756	.71579	.51974	57
+ 1′	9.70847	.51105	9.71032	.51323	9.71216	.51541	9.71399	.51760	9.71582	.51978	56
5	.70850	.51109	.71035	.51327	.71219	.51545	.71402	.51763	.71585	.51981	55
6	.70853	.51113	.71038	.51331	.71222	.51549	.71405	.51767	.71588	.51985	54
7	.70856	.51116	.71041	.51334	.71225	.51552	.71408	.51770	.71591	.51988	53
+ 2′	9.70859	.51120	9.71044	.51338	9.71228	.51556	9.71411	.51774	9.71594	.51992	52
9	.70862	.51123	.71047	.51342	.71231	.51560	.71414	.51778	.71597	.51996	51
10	.70865	.51127	.71050	.51345	.71234	.51563	.71417	.51781	.71600	.51999	50
11	.70868	.51131	.71053	.51349	.71237	.51567	.71420	.51785	.71603	.52003	49
+ 3′	9.70871	.51134	9.71056	.51352	9.71240	.51571	9.71423	.51789	9.71606	.52007	48
13	.70874	.51138	.71059	.51356	.71243	.51574	.71426	.51792	.71609	.52010	47
14	.70877	.51142	.71062	.51360	.71246	.51578	.71430	.51796	.71612	.52014	46
15	.70881	.51145	.71065	.51363	.71249	.51581	.71433	.51799	.71615	.52018	45
+ 4′	9.70884	.51149	9.71068	.51367	9.71252	.51585	9.71436	.51803	9.71618	.52021	44
17	.70887	.51153	.71072	.51371	.71255	.51589	.71439	.51807	.71621	.52025	43
18	.70890	.51156	.71075	.51374	.71259	.51592	.71442	.51810	.71624	.52028	42
19	.70893	.51160	.71078	.51378	.71262	.51596	.71445	.51814	.71627	.52032	41
+ 5′	9.70896	.51163	9.71081	.51382	9.71265	.51600	9.71448	.51818	9.71630	.52036	40
21	.70899	.51167	.71084	.51385	.71268	.51603	.71451	.51821	.71633	.52039	39
22	.70902	.51171	.71087	.51389	.71271	.51607	.71454	.51825	.71636	.52043	38
23	.70905	.51174	.71090	.51392	.71274	.51611	.71457	.51829	.71639	.52047	37
+ 6′	9.70908	.51178	9.71093	.51396	9.71277	.51614	9.71460	.51832	9.71642	.52050	36
25	.70911	.51182	.71096	.51400	.71280	.51618	.71463	.51836	.71645	.52054	35
26	.70914	.51185	.71099	.51403	.71283	.51621	.71466	.51839	.71648	.52057	34
27	.70918	.51189	.71102	.51407	.71286	.51625	.71469	.51843	.71651	.52061	33
+ 7′	9.70921	.51193	9.71105	.51411	9.71289	.51629	9.71472	.51847	9.71654	.52065	32
29	.70924	.51196	.71108	.51414	.71292	.51632	.71475	.51850	.71657	.52068	31
30	.70927	.51200	.71111	.51418	.71295	.51636	.71478	.51854	.71660	.52072	30
31	.70930	.51203	.71114	.51422	.71298	.51640	.71481	.51858	.71663	.52076	29
+ 8′	9.70933	.51207	9.71118	.51425	9.71301	.51643	9.71484	.51861	9.71666	.52079	28
33	.70936	.51211	.71121	.51429	.71304	.51647	.71487	.51865	.71670	.52083	27
34	.70939	.51214	.71124	.51432	.71307	.51650	.71490	.51869	.71673	.52087	26
35	.70942	.51218	.71127	.51436	.71311	.51654	.71493	.51872	.71676	.52090	25
+ 9′	9.70945	.51222	9.71130	.51440	9.71314	.51658	9.71496	.51876	9.71679	.52094	24
37	.70948	.51225	.71133	.51443	.71317	.51661	.71500	.51879	.71682	.52097	23
38	.70951	.51229	.71136	.51447	.71320	.51665	.71503	.51883	.71685	.52101	22
39	.70955	.51233	.71139	.51451	.71323	.51669	.71506	.51887	.71688	.52105	21
+ 10′	9.70958	.51236	9.71142	.51454	9.71326	.51672	9.71509	.51890	9.71691	.52108	20
41	.70961	.51240	.71145	.51458	.71329	.51676	.71512	.51894	.71694	.52112	19
42	.70964	.51243	.71148	.51462	.71332	.51680	.71515	.51898	.71697	.52116	18
43	.70967	.51247	.71151	.51465	.71335	.51683	.71518	.51901	.71700	.52119	17
+ 11′	9.70970	.51251	9.71154	.51469	9.71338	.51687	9.71521	.51905	9.71703	.52123	16
45	.70973	.51254	.71157	.51472	.71341	.51690	.71524	.51908	.71706	.52126	15
46	.70976	.51258	.71161	.51476	.71344	.51694	.71527	.51912	.71709	.52130	14
47	.70979	.51262	.71164	.51480	.71347	.51698	.71530	.51916	.71712	.52134	13
+ 12′	9.70982	.51265	9.71167	.51483	9.71350	.51701	9.71533	.51919	9.71715	.52137	12
49	.70985	.51269	.71170	.51487	.71353	.51705	.71536	.51923	.71718	.52141	11
50	.70988	.51273	.71173	.51491	.71356	.51709	.71539	.51927	.71721	.52145	10
51	.70992	.51276	.71176	.51494	.71359	.51712	.71542	.51930	.71724	.52148	9
+ 13′	9.70995	.51280	9.71179	.51498	9.71362	.51716	9.71545	.51934	9.71727	.52152	8
53	.70998	.51283	.71182	.51501	.71365	.51720	.71548	.51938	.71730	.52156	7
54	.71001	.51287	.71185	.51505	.71369	.51723	.71551	.51941	.71733	.52159	6
55	.71004	.51291	.71188	.51509	.71372	.51727	.71554	.51945	.71736	.52163	5
+ 14′	9.71007	.51294	9.71191	.51512	9.71375	.51730	9.71557	.51948	9.71739	.52166	4
57	.71010	.51298	.71194	.51516	.71378	.51734	.71560	.51952	.71742	.52170	3
58	.71013	.51302	.71197	.51520	.71381	.51738	.71563	.51956	.71745	.52174	2
59	.71016	.51305	.71200	.51523	.71384	.51741	.71566	.51959	.71748	.52177	1
+ 15′	9.71019	.51309	9.71203	.51527	9.71387	.51745	9.71569	.51963	9.71751	.52181	0
	$17^h\ 54^m$		$17^h\ 53^m$		$17^h\ 52^m$		$17^h\ 51^m$		$17^h\ 50^m$		

TABLE 45.

Haversines.

	6h 10m 92° 30′		*6h 11m* 92° 45′		*6h 12m* 93° 0′		*6h 13m* 93° 15′		*6h 14m* 93° 30′		
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	s
0	9.71751	.52181	9.71932	.52399	9.72112	.52617	9.72292	.52835	9.72471	.53052	*60*
1	.71754	.52185	.71935	.52403	.72115	.52620	.72295	.52838	.72474	.53056	*59*
2	.71757	.52188	.71938	.52406	.72118	.52624	.72298	.52842	.72476	.53060	*58*
3	.71760	.52192	.71941	.52410	.72121	.52628	.72301	.52846	.72479	.53063	*57*
+ 1′	9.71763	.52196	9.71944	.52413	9.72124	.52631	9.72304	.52849	9.72482	.53067	*56*
5	.71766	.52199	.71947	.52417	.72127	.52635	.72307	.52853	.72485	.53071	*55*
6	.71769	.52203	.71950	.52421	.72130	.52639	.72310	.52856	.72488	.53074	*54*
7	.71772	.52206	.71953	.52424	.72133	.52642	.72313	.52860	.72491	.53078	*53*
+ 2′	9.71775	.52210	9.71956	.52428	9.72136	.52646	9.72316	.52864	9.72494	.53081	*52*
9	.71778	.52214	.71959	.52432	.72139	.52649	.72319	.52867	.72497	.53085	*51*
10	.71781	.52217	.71962	.52435	.72142	.52653	.72322	.52871	.72500	.53089	*50*
11	.71784	.52221	.71965	.52439	.72145	.52657	.72325	.52875	.72503	.53092	*49*
+ 3′	9.71787	.52225	9.71968	.52442	9.72148	.52660	9.72328	.52878	9.72506	.53096	*48*
13	.71791	.52228	.71971	.52446	.72151	.52664	.72331	.52882	.72509	.53100	*47*
14	.71794	.52232	.71974	.52450	.72154	.52668	.72334	.52885	.72512	.53103	*46*
15	.71797	.52235	.71977	.52453	.72157	.52671	.72337	.52889	.72515	.53107	*45*
+ 4′	9.71800	.52239	9.71980	.52457	9.72160	.52675	9.72340	.52893	9.72518	.53110	*44*
17	.71803	.52243	.71983	.52461	.72163	.52679	.72343	.52896	.72521	.53114	*43*
18	.71806	.52246	.71986	.52464	.72166	.52682	.72346	.52900	.72524	.53118	*42*
19	.71809	.52250	.71989	.52468	.72169	.52686	.72349	.52904	.72527	.53121	*41*
+ 5′	9.71812	.52254	9 71992	.52472	9.72172	.52689	9.72352	.52907	9.72530	.53125	*40*
21	.71815	.52257	.71995	.52475	.72175	.52693	.72354	.52911	.72533	.53129	*39*
22	.71818	.52261	.71998	.52479	.72178	.52697	.72357	.52915	.72536	.53132	*38*
23	.71821	.52264	.72001	.52482	.72181	.52700	.72360	.52918	.72539	.53136	*37*
+ 6′	9.71824	.52268	9.72004	.52486	9.72184	.52704	9.72363	.52922	9.72542	.53140	*36*
25	.71827	.52272	.72007	.52490	.72187	.52708	.72366	.52925	.72545	.53143	*35*
26	.71830	.52275	.72010	.52493	.72190	.52711	.72369	.52929	.72548	.53147	*34*
27	.71833	.52279	.72013	.52497	.72193	.52715	.72372	.52933	.72551	.53150	*33*
+ 7′	9.71836	.52283	9.72016	.52501	9.72196	.52718	9.72375	.52936	9.72554	.53154	*32*
29	.71839	.52286	.72019	.52504	.72199	.52722	.72378	.52940	.72557	.53158	*31*
30	.71842	.52290	.72022	.52508	.72202	.52726	.72381	.52944	.72560	.53161	*30*
31	.71845	.52294	.72025	.52511	.72205	.52729	.72384	.52947	.72563	.53165	*29*
+ 8′	9.71848	.52297	9.72028	.52515	9.72208	.52733	9.72387	.52951	9.72565	.53169	*28*
33	.71851	.52301	.72031	.52519	.72211	.52737	.72390	.52954	.72568	.53172	*27*
34	.71854	.52304	.72034	.52522	.72214	.52740	.72393	.52958	.72571	.53176	*26*
35	.71857	.52308	.72037	.52526	.72217	.52744	.72396	.52962	.72574	.53179	*25*
+ 9′	9.71860	.52312	9.72040	.52530	9.72220	.52748	9.72399	.52965	9.72577	.53183	*24*
37	.71863	.52315	.72043	.52533	.72223	.52751	.72402	.52969	.72580	.53187	*23*
38	.71866	.52319	.72046	.52537	.72226	.52755	.72405	.52973	.72583	.53190	*22*
39	.71869	.52323	.72049	.52541	.72229	.52758	.72408	.52976	.72586	.53194	*21*
+ 10′	9.71872	.52326	9.72052	.52544	9.72232	.52762	9.72411	.52980	9.72589	.53198	*20*
41	.71875	.52330	.72055	.52548	.72235	.52766	.72414	.52983	.72592	.53201	*19*
42	.71878	.52334	.72058	.52551	.72238	.52769	.72417	.52987	.72595	.53205	*18*
43	.71881	.52337	.72061	.52555	.72241	.52773	.72420	.52991	.72598	.53208	*17*
+ 11′	9.71884	.52341	9.72064	.52559	9.72244	.52776	9.72423	.52994	9.72601	.53212	*16*
45	.71887	.52344	.72067	.52562	.72247	.52780	.72426	.52998	.72604	.53216	*15*
46	.71890	.52348	.72070	.52566	.72250	.52784	.72429	.53002	.72607	.53219	*14*
47	.71893	.52352	.72073	.52570	.72253	.52787	.72432	.53005	.72610	.53223	*13*
+ 12′	9.71896	.52355	9.72076	.52573	9.72256	.52791	9.72435	.53009	9.72613	.53227	*12*
49	.71899	.52359	.72079	.52577	.72259	.52795	.72438	.53013	.72616	.53230	*11*
50	.71902	.52363	.72082	.52580	.72262	.52798	.72441	.53016	.72619	.53234	*10*
51	.71905	.52366	.72085	.52584	.72265	.52802	.72444	.53020	.72622	.53238	*9*
+ 13′	9.71908	.52370	9.72088	.52588	9.72268	.52806	9.72447	.53023	9.72625	.53241	*8*
53	.71911	.52373	.72091	.52591	.72271	.52809	.72450	.53027	.72628	.53245	*7*
54	.71914	.52377	.72094	.52595	.72274	.52813	.72453	.53031	.72631	.53248	*6*
55	.71917	.52381	.72097	.52599	.72277	.52816	.72456	.53034	.72634	.53252	*5*
+ 14′	9.71920	.52384	9.72100	.52602	9.72280	.52820	9.72459	.53038	9.72637	.53256	*4*
57	.71923	.52388	.72103	.52606	.72283	.52824	.72462	.53042	.72640	.53259	*3*
58	.71926	.52392	.72106	.52610	.72286	.52827	.72465	.53045	.72642	.53263	*2*
59	.71929	.52395	.72119	.52613	.72289	.52831	.72468	.53049	.72645	.53267	*1*
+ 15′	9.71932	.52399	9.72112	.52617	9.72292	.52835	9.72471	.53052	9.72648	.53270	*0*
	17h 49m		*17h 48m*		*17h 47m*		*17h 46m*		*17h 45m*		

TABLE 45.

Haversines.

	$6^h\ 15^m$ 93° 45′		$6^h\ 16^m$ 94° 0′		$6^h\ 17^m$ 94° 15′		$6^h\ 18^m$ 94° 30′		$6^h\ 19^m$ 94° 45		
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	s
0	9.72648	.53270	9.72825	.53488	9.73002	.53705	9.73177	.53923	9.73352	.54140	60
1	.72651	.53274	.72828	.53491	.73005	.53709	.73180	.53927	.73355	.54144	59
2	.72654	.53277	.72831	.53495	.73008	.53713	.73183	.53930	.73358	.54148	58
3	.72657	.53281	.72834	.53499	.73011	.53716	.73186	.53934	.73361	.54151	57
+ 1′	9.72660	.53285	9.72837	.53502	9.73014	.53720	9.73189	.53937	9.73364	.54155	56
5	.72663	.53288	.72840	.53506	.73016	.53724	.73192	.53941	.73367	.54159	55
6	.72666	.53292	.72843	.53510	.73019	.53727	.73195	.53945	.73370	.54162	54
7	.72669	.53296	.72846	.53513	.73022	.53731	.73198	.53948	.73373	.54166	53
+ 2′	9.72672	.53299	9.72849	.53517	9.73025	.53734	9.73201	.53952	9.73375	.54169	52
9	.72675	.53303	.72852	.53520	.73028	.53738	.73204	.53956	.73378	.54173	51
10	.72678	.53306	.72855	.53524	.73031	.53742	.73207	.53959	.73381	.54177	50
11	.72681	.53310	.72858	.53528	.73034	.53745	.73209	.53963	.73384	.54180	49
+ 3′	9.72684	.53314	9.72861.	.53531	9.73037	.53749	9.73212	.53966	9.73387	.54184	48
13	.72687	.53317	.72864	.53535	.73040	.53753	.73215	.53970	.73390	.54188	47
14	.72690	.53321	.72867	.53539	.73043	.53756	.73218	.53974	.73393	.54191	46
15	.72693	.53325	.72870	.53542	.73046	.53760	.73221	.53977	.73396	.54195	45
+ 4′	9.72696	.53328	9.72873	.53546	9.73049	.53763	9.73224	.53981	9.73399	.54198	44
17	.72699	.53332	.72876	.53549	.73052	.53767	.73227	.53985	.73402	.54202	43
18	.72702	.53335	.72878	.53553	.73055	.53771	.73230	.53988	.73404	.54206	42
19	.72705	.53339	.72881	.53557	.73057	.53774	.73233	.53992	.73407	.54209	41
+ 5′	9.72708	.53343	9.72884	.53560	9.73060	.53778	9.73236	.53995	9.73410	.54213	40
21	.72710	.53346	.72887	.53564	.73063	.53782	.73239	.53999	.73413	.54217	39
22	.72713	.53350	.72890	.53568	.73066	.53785	.73242	.54003	.73416	.54220	38
23	.72716	.53354	.72893	.53571	.73069	.53789	.73244	.54006	.73419	.54224	37
+ 6′	9.72719	.53357	9.72896	.53575	9.73072	.53792	9.73247	.54010	9.73422	.54227	36
25	.72722	.53361	.72899	.53579	.73075	.53796	.73250	.54014	.73425	.54231	35
26	.72725	.53364	.72902	.53582	.75078	.53800	.73253	.54017	.73428	.54235	34
27	.72728	.53368	.72905.	.53586	.73081	.53803	.73256	.54021	.73431	.54238	33
+ 7′	9.72731	.53372	9.72908	.53589	9.73084	.53807	9.73259	.54024	9.73433	.54242	32
29	.72734	.53375	.72911	.53593	.73087	.53811	.73262	.54028	.73436	.54245	31
30	.72737	.53379	.72914	.53597	.73090	.53814	.73265	.54032	.73439	.54249	30
31	.72740	.53383	.72917	.53600	.73093	.53818	.73268	.54035	.73442	.54253	29
+ 8′	9.72743	.53386	9.72920	.53604	9.73096	.53821	9.73271	.54039	9.73445	.54256	28
33	.72746	.53390	.72923	.53608	.73098	.53825	.73274	.54043	.73448	.54260	27
34	.72749	.53394	.72926	.53611	.73101	.53829	.73277	.54046	.73451	.54264	26
35	.72752	.53397	.72928	.53615	.73104	.53832	.73280	.54050	.73454	.54267	25
+ 9′	9.72755	.53401	9.72931	.53618	9.73107	.53836	9.73282	.54053	9.73457	.54271	24
37	.72758	.53404	.72934	.53622	.73110	.53840	.73285	.54057	.73460	.54274	23
38	.72761	.53408	.72937	.53626	.73113	.53843	.73288	.54061	.73462	.54278	22
39	.72764	.53412	.72940	.53629	.73116	.53847	.73291	.54064	.73465	.54282	21
+ 10′	9.72767	.53415	9.72943	.53633	9.73119	.53850	9.73294	.54068	9.73468	.54285	20
41	.72770	.53419	.72946	.53637	.73122	.53854	.73297	.54072	.73471	.54289	19
42	.72772	.53423	.72949	.53640	.73125	.53858	.73300	.54075	.73474	.54293	18
43	.72775	.53426	.72952	.53644	.73128	.53861	.73303	.54079	.73477	.54296	17
+ 11′	9.72778	.53430	9.72955	.53647	9.73131	.53865	9.73306	.54083	9.73480	.54300	16
45	.72781	.53433	.72958	.53651	.73134	.53869	.73309	.54086	.73483	.54303	15
46	.72784	.53437	.72961	.53655	.73136	.53872	.73311	.54090	.73486	.54307	14
47	.72787	.53441	.72964	.53658	.73139	.53876	.73314	.54093	.73489	.54311	13
+ 12′	9.72790	.53444	9.72967	.53662	9.73142	.53879	9.73317	.54097	9.73491	.54314	12
49	.72793	.53448	.72970	.53666	.73145	.53883	.73320	.54101	.73494	.54318	11
50	.72796	.53452	.72972	.53669	.73148	.53887	.73323	.54104	.73497	.54322	10
51	.72799	.53455	.72975	.53673	.73151	.53890	.73326	.54108	.73500	.54325	9
+ 13′	9.72802	.53459	9.72978	.53676	9.73154	.53894	9.73329	.54111	9.73503	.54329	8
53	.72805	.53462	.72981	.53680	.73157	.53898	.73332	.54115	.73506	.54332	7
54	.72808	.53466	.72984	.53684	.73160	.53901	.73335	.54119	.73509	.54336	6
55	.72811	.53470	.72987	.53687	.73163	.53905	.73338	.54122	.73512	.54340	5
+ 14′	9.72814	.53473	9.72990	.53691	9.73166	.53908	9.73341	.54126	9.73515	.54343	4
57	.72817	.53477	.72993	.53695	.73169	.53912	.73343	.54130	.73517	.54347	3
58	.72820	.53481	.72996	.53698	.73172	.53916	.73346	.54133	.73520	.54351	2
59	.72823	.53484	.72999	.53702	.73174	.53919	.73349	.54137	.73523	.54354	1
+ 15′	9.72825	.53488	9.73002	.53705	9.73177	.53923	9.73352	.54140	9.73526	.54358	0
	$17^h\ 44^m$		$17^h\ 43^m$		$17^h\ 42^m$		$17^h\ 41^m$		$17^h\ 40^m$		

TABLE 45.

Haversines.

s	$6^h 20^m$ 95° 0′		$6^h 21^m$ 95° 15′		$6^h 22^m$ 95° 30′		$6^h 23^m$ 95° 45′		$6^h 24^m$ 96° 0′	
	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.
0	9.73526	.54358	9.73699	.54575	9.73872	.54792	9.74044	.55009	9.74215	.55226
1	.73529	.54361	.73702	.54579	.73875	.54796	.74047	.55013	.74218	.55230
2	.73532	.54365	.73705	.54582	.73878	.54800	.74049	.55017	.74220	.55234
3	.73535	.54369	.73708	.54586	.73881	.54803	.74052	.55020	.74223	.55237
+ 1′	9.73538	.54372	9.73711	.54590	9.73883	.54807	9.74055	.55024	9.74226	.55241
5	.73541	.54376	.73714	.54593	.73886	.54810	.74058	.55028	.74229	.55245
6	.73544	.54380	.73717	.54597	.73889	.54814	.74061	.55031	.74232	.55248
7	.73546	.54383	.73720	.54600	.73892	.54818	.74064	.55035	.74235	.55252
+ 2′	9.73549	.54387	9.73722	.54604	9.73895	.54821	9.74067	.55038	9.74237	.55255
9	.73552	.54390	.73725	.54608	.73898	.54825	.74069	.55042	.74240	.55259
10	.73555	.54394	.73728	.54611	.73901	.54828	.74072	.55046	.74243	.55263
11	.73558	.54398	.73731	.54615	.73903	.54832	.74075	.55049	.74246	.55266
+ 3′	9.73561	.54401	9.73734	.54619	9.73906	.54836	9.74078	.55053	9.74249	.55270
13	.73564	.54405	.73737	.54622	.73909	.54839	.74081	.55056	.74252	.55273
14	.73567	.54409	.73740	.54626	.73912	.54843	.74084	.55060	.74254	.55277
15	.73570	.54412	.73743	.54629	.73915	.54847	.74087	.55064	.74257	.55281
+ 4′	9.73572	.54416	9.73746	.54633	9.73918	.54850	9.74089	.55067	9.74260	.55284
17	.73575	.54419	.73748	.54637	.73921	.54854	.74092	.55071	.74263	.55288
18	.73578	.54423	.73751	.54640	.73924	.54857	.74095	.55075	.74266	.55292
19	.73581	.54427	.73754	.54644	.73926	.54861	.74098	.55078	.74269	.55295
+ 5′	9.73584	.54430	9.73757	.54647	9.73929	.54865	9.74101	.55082	9.74272	.55299
21	.73587	.54434	.73760	.54651	.73932	.54868	.74104	.55085	.74274	.55302
22	.73590	.54437	.73763	.54655	.73935	.54872	.74106	.55089	.74277	.55306
23	.73593	.54441	.73766	.54658	.73938	.54876	.74109	.55093	.74280	.55310
+ 6′	9.73596	.54445	9.73769	.54662	9.73941	.54879	9.74112	.55096	9.74283	.55313
25	.73598	.54448	.73771	.54666	.73944	.54883	.74115	.55100	.74286	.55317
26	.73601	.54452	.73774	.54669	.73946	.54886	.74118	.55103	.74289	.55320
27	.73604	.54456	.73777	.54673	.73949	.54890	.74121	.55107	.74291	.55324
+ 7′	9.73607	.54459	9.73780	.54676	9.73952	.54894	9.74124	.55111	9.74294	.55328
29	.73610	.54463	.73783	.54680	.73955	.54897	.74126	.55114	.74297	.55331
30	.73613	.54466	.73786	.54684	.73958	.54901	.74129	.55118	.74300	.55335
31	.73616	.54470	.73789	.54687	.73961	.54904	.74132	.55122	.74303	.55339
+ 8′	9.73619	.54474	9.73792	.54691	9.73964	.54908	9.74135	.55125	9.74306	.55342
33	.73622	.54477	.73794	.54695	.73967	.54912	.74138	.55129	.74308	.55346
34	.73624	.54481	.73797	.54698	.73969	.54915	.74141	.55132	.74311	.55349
35	.73627	.54485	.73800	.54702	.73972	.54919	.74144	.55136	.74314	.55353
+ 9′	9.73630	.54488	9.73803	.54705	9.73975	.54923	9.74146	.55140	9.74317	.55357
37	.73633	.54492	.73806	.54709	.73978	.54926	.74149	.55143	.74320	.55360
38	.73636	.54495	.73809	.54713	.73981	.54930	.74152	.55147	.74323	.55364
39	.73639	.54499	.73812	.54716	.73984	.54933	.74155	.55150	.74325	.55367
+ 10′	9.73642	.54503	9.73815	.54720	9.73987	.54937	9.74158	.55154	9.74328	.55371
41	.73645	.54506	.73817	.54724	.73989	.54941	.74161	.55158	.74331	.55375
42	.73648	.54510	.73820	.54727	.73992	.54944	.74163	.55161	.74334	.55378
43	.73650	.54514	.73823	.54731	.73995	.54948	.74166	.55165	.74337	.55382
+ 11′	9.73653	.54517	9.73826	.54734	9.73998	.54952	9.74169	.55168	9.74340	.55386
45	.73656	.54521	.73829	.54738	.74001	.54955	.74172	.55172	.74342	.55389
46	.73659	.54524	.73832	.54742	.74004	.54959	.74175	.55176	.74345	.55393
47	.73662	.54528	.73835	.54745	.74007	.54963	.74178	.55179	.74348	.55396
+ 12′	9.73665	.54532	9.73838	.54749	9.74009	.54966	9.74181	.55183	9.74351	.55400
49	.73668	.54535	.73840	.54752	.74012	.54970	.74183	.55187	.74354	.55404
50	.73671	.54539	.73843	.54756	.74015	.54973	.74186	.55190	.74357	.55407
51	.73674	.54542	.73846	.54760	.74018	.54977	.74189	.55194	.74359	.55411
+ 13′	9.73676	.54546	9.73849	.54763	9.74021	.54980	9.74192	.55197	9.74362	.55414
53	.73679	.54550	.73852	.54767	.74024	.54984	.74195	.55201	.74365	.55418
54	.73682	.54553	.73855	.54771	.74027	.54988	.74198	.55205	.74368	.55422
55	.73685	.54557	.73858	.54774	.74029	.54991	.74200	.55208	.74371	.55425
+ 14′	9.73688	.54561	9.73860	.54778	9.74032	.54995	9.74203	.55212	9.74374	.55429
57	.73691	.54564	.73863	.54781	.74035	.54999	.74206	.55216	.74376	.55433
58	.73694	.54568	.73866	.54785	.74038	.55002	.74209	.55219	.74379	.55436
59	.73697	.54571	.73869	.54789	.74041	.55006	.74212	.55223	.74382	.55440
+ 15′	9.73699	.54575	9.73872	.54792	9.74044	.55009	9.74215	.55226	9.74385	.55443
	$17^h 39^m$		$17^h 38^m$		$17^h 37^m$		$17^h 36^m$		$17^h 35^m$	

TABLE 45.

Haversines.

s	6h 25m 96° 15′		6h 26m 96° 30′		6h 27m 96° 45′		6h 28m 97° 0′		6h 29m 97° 15′		s
	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	
0	9.74385	.55443	9.74554	.55660	9.74723	.55877	9.74891	.56093	9.75059	.56310	60
1	.74388	.55447	.74557	.55664	.74726	.55880	.74894	.56097	.75061	.56314	59
2	.74391	.55451	.74560	.55667	.74729	.55884	.74897	.56101	.75064	.56317	58
3	.74393	.55454	.74563	.55671	.74732	.55888	.74900	.56104	.75067	.56321	57
+ 1′	9.74396	.55458	9.74566	.55675	9.74734	.55891	9.74902	.56108	9.75070	.56324	56
5	.74399	.55461	.74569	.55678	.74737	.55895	.74905	.56112	.75072	.56328	55
6	.74402	.55465	.74571	.55682	.74740	.55899	.74908	.56115	.75075	.56332	54
7	.74405	.55469	.74574	.55685	.74743	.55902	.74911	.56119	.75078	.56335	53
+ 2′	9.74408	.55472	9.74577	.55689	9.74746	.55906	9.74914	.56122	9.75081	.56339	52
9	.74410	.55476	.74580	.55693	.74748	.55909	.74916	.56126	.75084	.56342	51
10	.74413	.55479	.74583	.55696	.74751	.55913	.74919	.56130	.75086	.56346	50
11	.74416	.55483	.74585	.55700	.74754	.55917	.74922	.56133	.75089	.56350	49
+ 3′	9.74419	.55487	9.74588	.55704	9.74757	.55920	9.74925	.56137	9.75092	.56353	48
13	.74422	.55490	.74591	.55707	.74760	.55924	.74928	.56140	.75095	.56357	47
14	.74425	.55494	.74594	.55711	.74762	.55927	.74930	.56144	.75097	.56360	46
15	.74427	.55498	.74597	.55714	.74765	.55931	.74933	.56147	.75100	.56364	45
+ 4′	9.74430	.55501	9.74600	.55718	9.74768	.55935	9.74936	.56151	9.75103	.56368	44
17	.74433	.55505	.74602	.55722	.74771	.55938	.74939	.56155	.75106	.56371	43
18	.74436	.55508	.74605	.55725	.74774	.55942	.74941	.56158	.75109	.56375	42
19	.74439	.55512	.74603	.55729	.74776	.55945	.74944	.56162	.75111	.56378	41
+ 5′	9.74442	.55516	9.74611	.55732	9.74779	.55949	9.74947	.56166	9.75114	.56382	40
21	.74444	.55519	.74614	.55736	.74782	.55953	.74950	.56169	.75117	.56386	39
22	.74447	.55523	.74616	.55740	.74785	.55956	.74953	.56173	.75120	.56389	38
23	.74450	.55526	.74619	.55743	.74788	.55960	.74955	.56176	.75122	.56393	37
+ 6′	9.74453	.55530	9.74622	.55747	9.74791	.55964	9.74958	.56180	9.75125	.56397	36
25	.74456	.55534	.74625	.55750	.74793	.55967	.74961	.56184	.75128	.56400	35
26	.74458	.55537	.74628	.55754	.74796	.55971	.74964	.56187	.75131	.56404	34
27	.74461	.55541	.74630	.55758	.74799	.55974	.74967	.56191	.75134	.56407	33
+ 7′	9.74464	.55545	9.74633	.55761	9.74802	.55978	9.74969	.56195	9.75136	.56411	32
29	.74467	.55548	.74636	.55765	.74805	.55982	.74972	.56198	.75139	.56415	31
30	.74470	.55552	.74639	.55769	.74807	.55985	.74975	.56202	.75142	.56418	30
31	.74473	.55555	.74642	.55772	.74810	.55989	.74978	.56205	.75145	.56422	29
+ 8′	9.74475	.55559	9.74645	.55776	9.74813	.55992	9.74981	.56209	9.75147	.56425	28
33	.74478	.55563	.74647	.55779	.74816	.55996	.74983	.56213	.75150	.56429	27
34	.74481	.55566	.74650	.55783	.74819	.56000	.74986	.56216	.75153	.56433	26
35	.74484	.55570	.74653	.55787	.74821	.56003	.74989	.56220	.75156	.56436	25
+ 9′	9.74487	.55573	9.74656	.55790	9.74824	.56007	9.74992	.56223	9.75159	.56440	24
37	.74490	.55577	.74659	.55794	.74827	.56010	.74994	.56227	.75161	.56443	23
38	.74492	.55581	.74661	.55797	.74830	.56014	.74997	.56231	.75164	.56447	22
39	.74495	.55584	.74664	.55801	.74833	.56018	.75000	.56234	.75167	.56451	21
+ 10′	9.74498	.55588	9.74667	.55805	9.74835	.56021	9.75003	.56238	9.75170	.56454	20
41	.74501	.55592	.74670	.55808	.74838	.56025	.75006	.56241	.75172	.56458	19
42	.74504	.55595	.74673	.55812	.74841	.56029	.75008	.56245	.75175	.56461	18
43	.74506	.55599	.74675	.55815	.74844	.56032	.75011	.56249	.75178	.56465	17
+ 11′	9.74509	.55602	9.74678	.55819	9.74846	.56036	9.75014	.56252	9.75181	.56469	16
45	.74512	.55606	.74681	.55823	.74849	.56039	.75017	.56256	.75183	.56472	15
46	.74515	.55610	.74684	.55826	.74852	.56043	.75020	.56259	.75186	.56476	14
47	.74518	.55613	.74687	.55830	.74855	.56047	.75022	.56263	.75189	.56479	13
+ 12′	9.74521	.55617	9.74690	.55834	9.74858	.56050	9.75025	.56267	9.75192	.56483	12
49	.74523	.55620	.74692	.55837	.74860	.56054	.75028	.56270	.75195	.56487	11
50	.74526	.55624	.74695	.55841	.74863	.56057	.75031	.56274	.75197	.56490	10
51	.74529	.55628	.74698	.55844	.74866	.56061	.75033	.56277	.75200	.56494	9
+ 13′	9.74532	.55631	9.74701	.55848	9.74869	.56065	9.75036	.56281	9.75203	.56497	8
53	.74535	.55635	.74704	.55852	.74872	.56068	.75039	.56285	.75206	.56501	7
54	.74538	.55638	.74706	.55855	.74874	.56072	.75042	.56288	.75208	.56505	6
55	.74540	.55642	.74709	.55859	.74877	.56075	.75045	.56292	.75211	.56508	5
+ 14′	9.74543	.55646	9.74712	.55862	9.74880	.56079	9.75047	.56296	9.75214	.56512	4
57	.74546	.55649	.74715	.55866	.74883	.56083	.75050	.56299	.75217	.56516	3
58	.74549	.55653	.74718	.55870	.74886	.56086	.75053	.56303	.75220	.56519	2
59	.74552	.55657	.74720	.55873	.74888	.56090	.75056	.56306	.75222	.56523	1
+ 15′	9.74554	.55660	9.74723	.55877	9.74891	.56093	9.75059	.56310	9.75225	.56526	0
	17h 34m		17h 33m		17h 32m		17h 31m		17h 30m		

TABLE 45.

Haversines.

	$6^h 30^m$ 97° 30′		$6^h 31^m$ 97° 45′		$6^h 32^m$ 98° 0′		$6^h 33$
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Ha
0	9.75225	.56526	9.75391	.56743	9.75556	.56959	9.7572
1	.75228	.56530	.75394	.56746	.75559	.56962	.7572
2	.75231	.56534	.75396	.56750	.75561	.56966	.7572
3	.75233	.56537	.75399	.56753	.75564	.56969	.7572
+ 1′	9.75236	.56541	9.75402	.56757	9.75567	.56973	9.7573
5	.75239	.56544	.75405	.56761	.75570	.56977	.7573
6	.75242	.56548	.75407	.56764	.75572	.56980	.7573
7	.75244	.56552	.75410	.56768	.75575	.56984	.7573
+ 2′	9.75247	.56555	9.75413	.56771	9.75578	.56987	9.7574
9	.75250	.56559	.75416	.56775	.75581	.56991	.7574
10	.75253	.56562	.75418	.56779	.75583	.56994	.7574
11	.75256	.56566	.75421	.56782	.75586	.56998	.7575
+ 3′	9.75258	.56570	9.75424	.56786	9.75589	.57002	9.7575
13	.75261	.56573	.75427	.56789	.75592	.57005	.7575
14	.75264	.56577	.75429	.56793	.75594	.57009	.7575
15	.75267	.56580	.75432	.56797	.75597	.57012	.7576
+ 4′	9.75269	.56584	9.75435	.56800	9.75600	.57016	9.7576
17	.75272	.56588	.75438	.56804	.75603	.57020	.7576
18	.75275	.56591	.75440	.56807	.75605	.57023	.7577
19	.75278	.56595	.75443	.56811	.75608	.57027	.7577
+ 5′	9.75280	.56598	9.75446	.56815	9.75611	.57031	9.7577
21	.75283	.56602	.75449	.56818	.75614	.57034	.7577
22	.75286	.56606	.75452	.56822	.75616	.57038	.7578
23	.75289	.56609	.75454	.56825	.75619	.57041	.7578
+ 6′	9.75291	.56613	9.75457	.56829	9.75622	.57045	9.7578
25	.75294	.56616	.75460	.56833	.75625	.57049	.7578
26	.75297	.56620	.75463	.56836	.75627	.57052	.7579
27	.75300	.56624	.75465	.56840	.75630	.57056	.7579
+ 7′	9.75303	.56627	9.75468	.56843	9.75633	.57059	9.7579
29	.75305	.56631	.75471	.56847	.75636	.57063	.7580
30	.75308	.56634	.75474	.56851	.75638	.57067	.7580
31	.75311	.56638	.75476	.56854	.75641	.57070	.7580
+ 8′	9.75314	.56642	9.75479	.56858	9.75644	.57074	9.7580
33	.75316	.56645	.75482	.56861	.75646	.57077	.7581
34	.75319	.56649	.75485	.56865	.75649	.57081	.7581
35	.75322	.56652	.75487	.56869	.75652	.57085	.7581
+ 9′	9.75325	.56656	9.75490	.56872	9.75655	.57088	9.7581
37	.75327	.56660	.75493	.56876	.75657	.57092	.7582
38	.75330	.56663	.75496	.56879	.75660	.57095	.7582
39	.75333	.56667	.75498	.56883	.75663	.57099	.7582
+ 10′	9.75336	.56670	9.75501	.56887	9.75666	.57103	9.7583
41	.75338	.56674	.75504	.56890	.75668	.57106	.7583
42	.75341	.56678	.75507	.56894	.75671	.57110	.7583
43	.75344	.56681	.75509	.56897	.75674	.57114	.7583
+ 11′	9.75347	.56685	9.75512	.56901	9.75677	.57117	9.7584
45	.75350	.56689	.75515	.56905	.75679	.57121	.7584
46	.75352	.56692	.75518	.56908	.75682	.57124	.7584
47	.75355	.56696	.75520	.56912	.75685	.57128	.7584
+ 12′	9.75358	.56699	9.75523	.56915	9.75688	.57131	9.7585
49	.75361	.56703	.75526	.56919	.75690	.57135	.7585
50	.75363	.56707	.75529	.56923	.75693	.57139	.7585
51	.75366	.56710	.75531	.56926	.75696	.57142	.7585
+ 13′	9.75369	.56714	9.75534	.56930	9.75698	.57146	9.7586
53	.75372	.56717	.75537	.56933	.75701	.57149	.7586
54	.75374	.56721	.75540	.56937	.75704	.57153	.7586
55	.75377	.56725	.75542	.56941	.75707	.57157	.7587
+ 14′	9.75380	.56728	9.75545	.56944	9.75709	.57160	9.7587
57	.75383	.56732	.75548	.56948	.75712	.57164	.7587
58	.75385	.56735	.75550	.56951	.75715	.57167	.7587
59	.75388	.56739	.75553	.56955	.75718	.57171	.7588
+ 15′	9.75391	.56743	9.75556	.56959	9.75720	.57175	9.7588
	$17^h 29^m$		$17^h 28^m$		$17^h 27^m$		17

61828°—16——49

TABLE 45.

Haversines.

s	6h 35m 98° 45'		6h 36m 99° 0'		6h 37m 99° 15'		6h 38m 99° 30'		6h 39m 99° 45'		s
	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	
0	9.76047	.57606	9.76209	.57822	9.76371	.58037	9.76531	.58252	9.76691	.58467	60
1	.76050	.57610	.76212	.57825	.76373	.58041	.76534	.58256	.76694	.58471	59
2	.76052	.57613	.76215	.57829	.76376	.58044	.76537	.58260	.76697	.58475	58
3	.76055	.57617	.76217	.57832	.76379	.58048	.76539	.58263	.76699	.58478	57
+ 1'	9.76058	.57621	9.76220	.57836	9.76381	.58051	9.76542	.58267	9.76702	.58482	56
5	.76060	.57624	.76223	.57840	.76384	.58055	.76545	.58270	.76705	.58485	55
6	.76063	.57628	.76225	.57843	.76387	.58059	.76547	.58274	.76707	.58489	54
7	.76066	.57631	.76228	.57847	.76389	.58062	.76550	.58277	.76710	.58493	53
+ 2'	9.76069	.57635	9.76231	.57850	9.76392	.58066	9.76553	.58281	9.76713	.58496	52
9	.76071	.57639	.76233	.57854	.76395	.58069	.76555	.58285	.76715	.58500	51
10	.76074	.57642	.76236	.57858	.76397	.58073	.76558	.58288	.76718	.58503	50
11	.76077	.57646	.76239	.57861	.76400	.58077	.76561	.58292	.76721	.58507	49
+ 3'	9.76079	.57649	9.76241	.57865	9.76403	.58080	9.76563	.58295	9.76723	.58510	48
13	.76082	.57653	.76244	.57868	.76405	.58084	.76566	.58299	.76726	.58514	47
14	.76085	.57656	.76247	.57872	.76408	.58087	.76569	.58303	.76729	.58518	46
15	.76088	.57660	.76250	.57876	.76411	.58091	.76571	.58306	.76731	.58521	45
+ 4'	9.76090	.57664	9.76252	.57879	9.76414	.58095	9.76574	.58310	9.76734	.58525	44
17	.76093	.57667	.76255	.57883	.76416	.58098	.76577	.58313	.76737	.58528	43
18	.76096	.57671	.76258	.57886	.76419	.58102	.76579	.58317	.76739	.58532	42
19	.76098	.57675	.76260	.57890	.76422	.58105	.76582	.58321	.76742	.58536	41
+ 5'	9.76101	.57678	9.76263	.57894	9.76424	.58109	9.76585	.58324	9.76745	.58539	40
21	.76104	.57682	.76266	.57897	.76427	.58112	.76587	.58328	.76747	.58543	39
22	.76106	.57685	.76268	.57901	.76430	.58116	.76590	.58331	.76750	.58546	38
23	.76109	.57689	.76271	.57904	.76432	.58120	.76593	.58335	.76753	.58550	37
+ 6'	9.76112	.57692	9.76274	.57908	9.76435	.58123	9.76595	.58338	9.76755	.58553	36
25	.76115	.57696	.76276	.57911	.76438	.58127	.76598	.58342	.76758	.58557	35
26	.76117	.57700	.76279	.57915	.76440	.58130	.76601	.58346	.76761	.58561	34
27	.76120	.57703	.76282	.57919	.76443	.58134	.76603	.58349	.76763	.58564	33
+ 7'	9.76123	.57707	9.76285	.57922	9.76446	.58138	9.76606	.58353	9.76766	.58568	32
29	.76125	.57710	.76287	.57926	.76448	.58141	.76609	.58356	.76769	.58571	31
30	.76128	.57714	.76290	.57929	.76451	.58145	.76611	.58360	.76771	.58575	30
31	.76131	.57718	.76293	.57933	.76454	.58148	.76614	.58364	.76774	.58579	29
+ 8'	9.76134	.57721	9.76296	.57937	9.76456	.58152	9.76617	.58367	9.76777	.58582	28
33	.76136	.57725	.76298	.57940	.76459	.58156	.76619	.58371	.76779	.58586	27
34	.76139	.57728	.76301	.57944	.76462	.58159	.76622	.58374	.76782	.58589	26
35	.76142	.57732	.76303	.57947	.76464	.58163	.76625	.58378	.76784	.58593	25
+ 9'	9.76144	.57736	9.76306	.57951	9.76467	.58166	9.76627	.58381	9.76787	.58596	24
37	.76147	.57739	.76309	.57955	.76470	.58170	.76630	.58385	.76790	.58600	23
38	.76150	.57743	.76311	.57958	.76473	.58173	.76633	.58389	.76792	.58604	22
39	.76152	.57746	.76314	.57962	.76475	.58177	.76635	.58392	.76795	.58607	21
+ 10'	9.76155	.57750	9.76317	.57965	9.76478	.58181	9.76638	.58396	9.76798	.58611	20
41	.76158	.57753	.76320	.57969	.76481	.58184	.76641	.58399	.76800	.58614	19
42	.76161	.57757	.76322	.57973	.76483	.58188	.76643	.58403	.76803	.58618	18
43	.76163	.57761	.76325	.57976	.76486	.58191	.76646	.58407	.76806	.58622	17
+ 11'	9.76166	.57764	9.76328	.57980	9.76489	.58195	9.76649	.58410	9.76808	.58625	16
45	.76169	.57768	.76330	.57983	.76491	.58199	.76651	.58414	.76811	.58629	15
46	.76171	.57771	.76333	.57987	.76494	.58202	.76654	.58417	.76814	.58632	14
47	.76174	.57775	.76336	.57990	.76497	.58206	.76657	.58421	.76816	.58636	13
+ 12'	9.76177	.57779	9.76338	.57994	9.76499	.58209	9.76659	.58424	9.76819	.58639	12
49	.76179	.57782	.76341	.57998	.76502	.58213	.76662	.58428	.76822	.58643	11
50	.76182	.57786	.76344	.58001	.76505	.58217	.76665	.58432	.76824	.58647	10
51	.76185	.57789	.76346	.58005	.76507	.58220	.76667	.58435	.76827	.58650	9
+ 13'	9.76188	.57793	9.76349	.58008	9.76510	.58224	9.76670	.58439	9.76830	.58654	8
53	.76190	.57797	.76352	.58012	.76513	.58227	.76673	.58442	.76832	.58657	7
54	.76193	.57800	.76354	.58016	.76515	.58231	.76675	.58446	.76835	.58661	6
55	.76196	.57804	.76357	.58019	.76518	.58234	.76678	.58450	.76838	.58665	5
+ 14'	9.76198	.57807	9.76360	.58023	9.76521	.58238	9.76681	.58453	9.76840	.58668	4
57	.76201	.57811	.76363	.58026	.76523	.58242	.76683	.58457	.76843	.58671	3
58	.76204	.57815	.76365	.58030	.76526	.58245	.76686	.58460	.76845	.58675	2
59	.76206	.57818	.76368	.58034	.76529	.58249	.76689	.58464	.76848	.58679	1
+ 15'	9.76209	.57822	9.76371	.58037	9.76531	.58252	9.76691	.58467	9.76851	.58682	0
	17h 24m		17h 23m		17h 22m		17h 21m		17h 20m		

TABLE 45.

Haversines.

	$6^h 40^m$ 100° 0′		$6^h 41^m$ 100° 15′		$6^h 42^m$ 100° 30′		$6^h 4$
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log.
0	9.76851	.58682	9.77009	.58897	9.77167	.59112	9.773
1	.76853	.58686	.77012	.58901	.77170	.59115	.773
2	.76856	.58690	.77015	.58904	.77173	.59119	.773
3	.76859	.58693	.77017	.58908	.77175	.59122	.773
+ 1′	9.76861	.58697	9.77020	.58911	9.77178	.59126	9.773
5	.76864	.58700	.77023	.58915	.77181	.59130	.773
6	.76867	.58704	.77025	.58919	.77183	.59133	.773
7	.76869	.58707	.77028	.58922	.77186	.59137	.773
+ 2′	9.76872	.58711	9.77031	.58926	9.77188	.59140	9.773
9	.76875	.58714	.77033	.58929	.77191	.59144	.773
10	.76877	.58718	.77036	.58933	.77194	.59148	.773
11	.76880	.58722	.77038	.58937	.77196	.59151	.773
+ 3′	9.76883	.58725	9.77041	.58940	9.77199	.59155	9.773
13	.76885	.58729	.77044	.58944	.77202	.59158	.773
14	.76888	.58733	.77046	.58947	.77204	.59162	.773
15	.76891	.58736	.77049	.58951	.77207	.59165	.773
+ 4′	9.76893	.58740	9.77052	.58954	9.77209	.59169	9.773
17	.76896	.58743	.77054	.58958	.77212	.59173	.773
18	.76898	.58747	.77057	.58962	.77215	.59176	.773
19	.76901	.58750	.77060	.58965	.77217	.59180	.773
+ 5′	9.76904	.58754	9.77062	.58969	9.77220	.59183	9.773
21	.76906	.58758	.77065	.58972	.77223	.59187	.773
22	.76909	.58761	.77067	.58976	.77225	.59190	.773
23	.76912	.58765	.77070	.58979	.77228	.59194	.773
+ 6′	9.76914	.58768	9.77073	.58983	9.77230	.59198	9.773
25	.76917	.58772	.77075	.58987	.77233	.59201	.773
26	.76920	.58776	.77078	.58990	.77236	.59205	.773
27	.76922	.58779	.77081	.58994	.77238	.59208	.773
+ 7′	9.76925	.58783	9.77083	.58997	9.77241	.59212	9.773
29	.76928	.58786	.77086	.59001	.77243	.59215	.774
30	.76930	.58790	.77089	.59005	.77246	.59219	.774
31	.76933	.58793	.77091	.59008	.77249	.59223	.774
+ 8′	9.76936	.58797	9.77094	.59012	9.77251	.59226	9.774
33	.76938	.58801	.77096	.59015	.77254	.59230	.774
34	.76941	.58804	.77099	.59019	.77257	.59233	.774
35	.76943	.58808	.77102	.59022	.77259	.59237	.774
+ 9′	9.76946	.58811	9.77104	.59026	9.77262	.59240	9.774
37	.76949	.58815	.77107	.59030	.77264	.59244	.774
38	.76951	.58818	.77110	.59033	.77267	.59248	.774
39	.76954	.58822	.77112	.59037	.77270	.59251	.774
+ 10′	9.76957	.58826	9.77115	.59040	9.77272	.59255	9.774
41	.76959	.58829	.77117	.59044	.77275	.59258	.774
42	.76962	.58833	.77120	.59047	.77278	.59262	.774
43	.76965	.58836	.77123	.59051	.77280	.59265	.774
+ 11′	9.76967	.58840	9.77125	.59055	9.77283	.59269	9.774
45	.76970	.58843	.77128	.59058	.77285	.59273	.774
46	.76972	.58847	.77131	.59062	.77288	.59276	.774
47	.76975	.58851	.77133	.59065	.77291	.59280	.774
+ 12′	9.76978	.58854	9.77136	.59069	9.77293	.59283	9.774
49	.76980	.58858	.77139	.59072	.77296	.59287	.774
50	.76983	.58861	.77141	.59076	.77298	.59290	.774
51	.76986	.58865	.77144	.59080	.77301	.59294	.774
+ 13′	9.76988	.58869	9.77146	.59083	9.77304	.59298	9.774
53	.76991	.58872	.77149	.59087	.77306	.59301	.774
54	.76994	.58876	.77152	.59090	.77309	.59305	.774
55	.76996	.58879	.77154	.59094	.77312	.59308	.774
+ 14′	9.76999	.58883	9.77157	.59097	9.77314	.59312	9.774
57	.77002	.58886	.77160	.59101	.77317	.59315	.774
58	.77004	.58890	.77162	.59105	.77319	.59319	.774
59	.77007	.58894	.77165	.59108	.77322	.59323	.774
+ 15′	9.77009	.58897	9.77167	.59112	9.77325	.59326	9.774
	$17^h 19^m$		$17^h 18^m$		$17^h 17^m$		

TABLE 45.

Haversines.

	$6^h\ 45^m$ 101° 15′		$6^h\ 46^m$ 101° 30′		$6^h\ 47^m$ 101° 45′		$6^h\ 48^m$ 102° 0′		$6^h\ 49^m$ 102° 15′		
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	s
0	9.77637	.59755	9.77792	.59968	9.77947	.60182	9.78101	.60396	9.78254	.60609	60
1	.77640	.59758	.77795	.59972	.77949	.60185	.78103	.60399	.78256	.60612	59
2	.77642	.59762	.77797	.59976	.77952	.60189	.78106	.60403	.78259	.60616	58
3	.77645	.59765	.77800	.59979	.77954	.60193	.78108	.60406	.78261	.60620	57
+ 1′	9.77647	.59769	9.77803	.59983	9.77957	.60196	9.78111	.60410	9.78264	.60623	56
5	.77650	.59772	.77805	.59986	.77960	.60200	.78113	.60414	.78266	.60627	55
6	.77653	.59776	.77808	.59990	.77962	.60203	.78116	.60417	.78269	.60630	54
7	.77655	.59779	.77810	.59993	.77965	.60207	.78118	.60420	.78271	.60634	53
+ 2′	9.77658	.59783	9.77813	.59997	9.77967	.60211	9.78121	.60424	9.78274	.60637	52
9	.77660	.59787	.77815	.60000	.77970	.60214	.78124	.60428	.78277	.60641	51
10	.77663	.59790	.77818	.60004	.77972	.60218	.78126	.60431	.78279	.60644	50
11	.77666	.59794	.77821	.60008	.77975	.60221	.78129	.60435	.78282	.60648	49
+ 3′	9.77668	.59797	9.77823	.60011	9.77978	.60225	9.78131	.60438	9.78284	.60652	48
13	.77671	.59801	.77826	.60015	.77980	.60228	.78134	.60442	.78287	.60655	47
14	.77673	.59804	.77828	.60018	.77983	.60232	.78136	.60445	.78289	.60659	46
15	.77676	.59808	.77831	.60022	.77985	.60235	.78139	.60449	.78292	.60662	45
+ 4′	9.77679	.59812	9.77834	.60025	9.77988	.60239	9.78141	.60452	9.78294	.60666	44
17	.77681	.59815	.77836	.60029	.77990	.60243	.78144	.60456	.78297	.60669	43
18	.77684	.59819	.77839	.60033	.77993	.60246	.78147	.60460	.78299	.60673	42
19	.77686	.59822	.77841	.60036	.77996	.60250	.78149	.60463	.78302	.60676	41
+ 5′	9.77689	.59826	9.77844	.60040	9.77998	.60253	9.78152	.60467	9.78305	.60680	40
21	.77691	.59829	.77846	.60043	.78001	.60257	.78154	.60470	.78307	.60684	39
22	.77694	.59833	.77849	.60047	.78003	.60260	.78157	.60474	.78310	.60687	38
23	.77697	.59837	.77852	.60050	.78006	.60264	.78159	.60477	.78312	.60691	37
+ 6′	9.77699	.59840	9.77854	.60054	9.78008	.60268	9.78162	.60481	9.78315	.60694	36
25	.77702	.59844	.77857	.60057	.78011	.60271	.78164	.60484	.78317	.60698	35
26	.77704	.59847	.77859	.60061	.78013	.60275	.78167	.60488	.78320	.60701	34
27	.77707	.59851	.77862	.60065	.78016	.60278	.78170	.60492	.78322	.60705	33
+ 7′	9.77710	.59854	9.77864	.60068	9.78019	.60282	9.78172	.60495	9.78325	.60708	32
29	.77712	.59858	.77867	.60072	.78021	.60285	.78175	.60499	.78327	.60712	31
30	.77715	.59861	.77870	.60075	.78024	.60289	.78177	.60502	.78330	.60715	30
31	.77717	.59865	.77872	.60079	.78026	.60292	.78180	.60506	.78332	.60719	29
+ 8′	9.77720	.59869	9.77875	.60082	9.78029	.60296	9.78182	.60509	9.78335	.60722	28
33	.77723	.59872	.77877	.60086	.78031	.60300	.78185	.60513	.78338	.60726	27
34	.77725	.59876	.77880	.60090	.78034	.60303	.78187	.60516	.78340	.60730	26
35	.77728	.59879	.77882	.60093	.78037	.60307	.78190	.60520	.78343	.60733	25
+ 9′	9.77730	.59883	9.77885	.60097	9.78039	.60310	9.78192	.60524	9.78345	.60737	24
37	.77733	.59886	.77888	.60100	.78042	.60314	.78195	.60527	.78348	.60740	23
38	.77735	.59890	.77890	.60104	.78044	.60317	.78198	.60531	.78350	.60744	22
39	.77738	.59894	.77893	.60107	.78047	.60321	.78200	.60534	.78353	.60747	21
+ 10′	9.77741	.59897	9.77895	.60111	9.78049	.60324	9.78203	.60538	9.78355	.60751	20
41	.77743	.59901	.77898	.60114	.78052	.60328	.78205	.60541	.78358	.60755	19
42	.77746	.59904	.77900	.60118	.78054	.60332	.78208	.60545	.78360	.60758	18
43	.77748	.59908	.77903	.60122	.78057	.60335	.78210	.60548	.78363	.60762	17
+ 11′	9.77751	.59911	9.77906	.60125	9.78060	.60339	9.78213	.60552	9.78365	.60765	16
45	.77754	.59915	.77908	.60129	.78062	.60342	.78215	.60556	.78368	.60769	15
46	.77756	.59919	.77911	.60132	.78065	.60346	.78218	.60559	.78371	.60772	14
47	.77759	.59922	.77913	.60136	.78067	.60349	.78221	.60563	.78373	.60776	13
+ 12′	9.77761	.59926	9.77916	.60139	9.78070	.60353	9.78223	.60566	9.78376	.60779	12
49	.77764	.59929	.77918	.60143	.78072	.60356	.78226	.60570	.78378	.60783	11
50	.77766	.59933	.77921	.60146	.78075	.60360	.78228	.60573	.78381	.60786	10
51	.77769	.59936	.77924	.60150	.78077	.60364	.78231	.60577	.78383	.60790	9
+ 13′	9.77772	.59940	9.77926	.60154	9.78080	.60367	9.78233	.60580	9.78386	.60793	8
53	.77774	.59943	.77929	.60157	.78083	.60371	.78236	.60584	.78388	.60797	7
54	.77777	.59947	.77931	.60161	.78085	.60374	.78238	.60588	.78391	.60801	6
55	.77779	.59951	.77934	.60164	.78088	.60378	.78241	.60591	.78393	.60804	5
+ 14′	9.77782	.59954	9.77936	.60168	9.78090	.60381	9.78243	.60595	9.78396	.60808	4
57	.77785	.59958	.77939	.60171	.78093	.60385	.78246	.60598	.78398	.60811	3
58	.77787	.59961	.77942	.60175	.78095	.60388	.78249	.60602	.78401	.60815	2
59	.77790	.59965	.77944	.60179	.78098	.60392	.78251	.60605	.78404	.60818	1
+ 15′	9.77792	.59968	9.77947	.60182	9.78101	.60396	9.78254	.60609	9.78406	.60822	0
	$17^h\ 14^m$		$17^h\ 13^m$		$17^h\ 12^m$		$17^h\ 11^m$		$17^h\ 10^m$		

TABLE 45.

Haversines.

	6h 50m 102° 30′		6h 51m 102° 45′		6h 52m 103° 0′		6h 53m 103° 15′		6h 54m 103° 30′		
s	Log. Hav.	Nat. Hav.	Hav.Log.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	s
0	9.78406	.60822	9.78558	.61035	9.78709	.61248	9.78859	.61460	9.79009	.61672	60
1	.78409	.60825	.78560	.61038	.78711	.61251	.78862	.61464	.79011	.61676	59
2	.78411	.60829	.78563	.61042	.78714	.61255	.78864	.61467	.79014	.61679	58
3	.78414	.60833	.78565	.61046	.78716	.61258	.78867	.61471	.79016	.61683	57
+ 1′	9.78416	.60836	9.78568	.61049	9.78719	.61262	9.78869	.61474	9.79019	.61686	56
5	.78419	.60840	.78570	.61053	.78721	.61265	.78872	.61478	.79021	.61690	55
6	.78421	.60843	.78573	.61056	.78724	.61269	.78874	.61481	.79024	.61693	54
7	.78424	.60847	.78575	.61060	.78726	.61272	.78877	.61485	.79026	.61697	53
+ 2′	9.78426	.60850	9.78578	.61063	9.78729	.61276	9.78879	.61488	9.79029	.61701	52
9	.78429	.60854	.78581	.61067	.78731	.61279	.78882	.61492	.79031	.61704	51
10	.78431	.60857	.78583	.61070	.78734	.61283	.78884	.61495	.79034	.61708	50
11	.78434	.60861	.78586	.61074	.78737	.61287	.78887	.61499	.79036	.61711	49
+ 3′	9.78436	.60865	9.78588	.61077	9.78739	.61290	9.78889	.61502	9.79039	.61715	48
13	.78439	.60868	.78591	.61081	.78742	.61294	.78892	.61506	.79041	.61718	47
14	.78442	.60872	.78593	.61085	.78744	.61297	.78894	.61510	.79044	.61722	46
15	.78444	.60875	.78596	.61088	.78747	.61301	.78897	.61513	.79046	.61725	45
+ 4′	9.78447	.60879	9.78598	.61092	9.78749	.61304	9.78899	.61517	9.79049	.61729	44
17	.78449	.60882	.78601	.61095	.78752	.61308	.78902	.61520	.79051	.61732	43
18	.78452	.60886	.78603	.61099	.78754	.61311	.78904	.61524	.79054	.61736	42
19	.78454	.60889	.78606	.61102	.78757	.61315	.78907	.61527	.79056	.61739	41
+ 5′	9.78457	.60893	9.78608	.61106	9.78759	.61318	9.78909	.61531	9.79059	.61743	40
21	.78459	.60897	.78611	.61109	.78762	.61322	.78912	.61534	.79061	.61747	39
22	.78462	.60900	.78613	.61113	.78764	.61325	.78914	.61538	.79064	.61750	38
23	.78464	.60904	.78616	.61116	.78767	.61329	.78917	.61541	.79066	.61754	37
+ 6′	9.78467	.60907	9.78618	.61120	9.78769	.61333	9.78919	.61545	9.79069	.61757	36
25	.78469	.60911	.78621	.61124	.78772	.61336	.78922	.61548	.79071	.61761	35
26	.78472	.60914	.78623	.61127	.78774	.61340	.78924	.61552	.79074	.61764	34
27	.78474	.60918	.78626	.61131	.78777	.61343	.78927	.61556	.79076	.61768	33
+ 7′	9.78477	.60921	9.78628	.61134	9.78779	.61347	9.78929	.61559	9.79079	.61771	32
29	.78479	.60925	.78631	.61138	.78782	.61350	.78932	.61563	.79081	.61775	31
30	.78482	.60928	.78633	.61141	.78784	.61354	.78934	.61566	.79084	.61778	30
31	.78485	.60932	.78636	.61145	.78787	.61357	.78937	.61570	.79086	.61782	29
+ 8′	9.78487	.60936	9.78638	.61148	9.78789	.61361	9.78939	.61573	9.79089	.61785	28
33	.78490	.60939	.78641	.61152	.78792	.61364	.78942	.61577	.79091	.61789	27
34	.78492	.60943	.78643	.61155	.78794	.61368	.78944	.61580	.79094	.61792	26
35	.78495	.60946	.78646	.61159	.78797	.61372	.78947	.61584	.79096	.61796	25
+ 9′	9.78497	.60950	9.78649	.61163	9.78799	.61375	9.78949	.61587	9.79099	.61800	24
37	.78500	.60953	.78651	.61166	.78802	.61379	.78952	.61591	.79101	.61803	23
38	.78502	.60957	.78654	.61170	.78804	.61382	.78954	.61594	.79103	.61807	22
39	.78505	.60960	.78656	.61173	.78807	.61386	.78957	.61598	.79106	.61810	21
+ 10′	9.78507	.60964	9.78659	.61177	9.78809	.61389	9.78959	.61602	9.79108	.61814	20
41	.78510	.60967	.78661	.61180	.78812	.61393	.78962	.61605	.79111	.61817	19
42	.78512	.60971	.78664	.61184	.78814	.61396	.78964	.61609	.79113	.61821	18
43	.78515	.60975	.78666	.61187	.78817	.61400	.78967	.61612	.79116	.61824	17
+ 11′	9.78517	.60978	9.78669	.61191	9.78819	.61403	9.78969	.61616	9.79118	.61828	16
45	.78520	.60982	.78671	.61194	.78822	.61407	.78972	.61619	.79121	.61831	15
46	.78522	.60985	.78674	.61198	.78824	.61410	.78974	.61623	.79123	.61835	14
47	.78525	.60989	.78676	.61201	.78827	.61414	.78977	.61626	.79126	.61838	13
+ 12′	9.78528	.60992	9.78679	.61205	9.78829	.61418	9.78979	.61630	9.79128	.61842	12
49	.78530	.60996	.78681	.61209	.78832	.61421	.78982	.61633	.79131	.61845	11
50	.78533	.60999	.78684	.61212	.78834	.61425	.78984	.61637	.79133	.61849	10
51	.78535	.61003	.78686	.61216	.78837	.61428	.78987	.61640	.79136	.61853	9
+ 13′	9.78538	.61007	9.78689	.61219	9.78839	.61432	9.78989	.61644	9.79138	.61856	8
53	.78540	.61010	.78691	.61223	.78842	.61435	.78992	.61648	.79141	.61860	7
54	.78543	.61014	.78694	.61226	.78844	.61439	.78994	.61651	.79143	.61863	6
55	.78545	.61017	.78696	.61230	.78847	.61442	.78997	.61655	.79146	.61867	5
+ 14′	9.78548	.61021	9.78699	.61233	9.78849	.61446	9.78999	.61658	9.79148	.61870	4
57	.78550	.61024	.78701	.61237	.78852	.61449	.79002	.61662	.79151	.61874	3
58	.78553	.61028	.78704	.61240	.78854	.61453	.79004	.61665	.79153	.61877	2
59	.78555	.61032	.78706	.61244	.78857	.61456	.79007	.61669	.79156	.61881	1
+ 15′	9.78558	.61035	9.78709	.61248	9.78859	.61460	9.79009	.61672	9.79158	.61884	0
	17h 9m		17h 8m		17h 7m		17h 6m		17h 5m		

TABLE 45.

Haversines.

	$6^h\ 55^m$ 103° 45′		$6^h\ 56^m$ 104° 0′		$6^h\ 57^m$ 104° 15′		$6^h\ 58^m$ 104° 30′		$6^h\ 59^m$ 104° 45′		
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	s
0	9.79158	.61884	9.79306	.62096	9.79454	.62308	9.79601	.62519	9.79748	.62730	60
1	.79161	.61888	.79309	.62100	.79457	.62311	.79604	.62522	.79750	.62734	59
2	.79163	.61891	.79311	.62103	.79459	.62315	.79606	.62526	.79752	.62737	58
3	.79165	.61895	.79314	.62107	.79462	.62318	.79609	.62530	.79755	.62741	57
+ 1′	9.79168	.61898	9.79316	.62110	9.79464	.62322	9.79611	.62533	9.79757	.62744	56
5	.79170	.61902	.79319	.62114	.79466	.62325	.79613	.62537	.79760	.62748	55
6	.79173	.61905	.79321	.62117	.79469	.62329	.79616	.62540	.79762	.62751	54
7	.79175	.61909	.79324	.62121	.79471	.62332	.79618	.62544	.79765	.62755	53
+ 2′	9.79178	.61913	9.79326	.62124	9.79474	.62336	9.79621	.62547	9.79767	.62758	52
9	.79180	.61916	.79329	.62128	.79476	.62339	.79623	.62551	.79770	.62762	51
10	.79183	.61920	.79331	.62131	.79479	.62343	.79626	.62554	.79772	.62765	50
11	.79185	.61923	.79334	.62135	.79481	.62346	.79628	.62558	.79774	.62769	49
+ 3′	9.79188	.61927	9.79336	.62138	9.79484	.62350	9.79631	.62561	9.79777	.62772	48
13	.79190	.61930	.79339	.62142	.79486	.62353	.79633	.62565	.79779	.62776	47
14	.79193	.61934	.79341	.62145	.79489	.62357	.79635	.62568	.79782	.62779	46
15	.79195	.61937	.79343	.62149	.79491	.62361	.79638	.62572	.79784	.62783	45
+ 4′	9.79198	.61941	9.79346	.62153	9.79493	.62364	9.79640	.62575	9.79787	.62786	44
17	.79200	.61944	.79348	.62156	.79496	.62368	.79643	.62579	.79789	.62790	43
18	.79203	.61948	.79351	.62160	.79498	.62371	.79645	.62582	.79791	.62793	42
19	.79205	.61951	.79353	.62163	.79501	.62375	.79648	.62586	.79794	.62797	41
+ 5′	9.79208	.61955	9.79356	.62167	9.79503	.62378	9.79650	.62589	9.79796	.62800	40
21	.79210	.61958	.79358	.62170	.79506	.62382	.79653	.62593	.79799	.62804	39
22	.79213	.61962	.79361	.62174	.79508	.62385	.79655	.62596	.79801	.62807	38
23	.79215	.61966	.79363	.62177	.79511	.62389	.79657	.62600	.79804	.62811	37
+ 6′	9.79217	.61969	9.79366	.62181	9.79513	.62392	9.79660	.62603	9.79806	.62814	36
25	.79220	.61973	.79368	.62184	.79516	.62396	.79662	.62607	.79808	.62818	35
26	.79222	.61976	.79371	.62188	.79518	.62399	.79665	.62611	.79811	.62822	34
27	.79225	.61980	.79373	.62191	.79520	.62403	.79667	.62614	.79813	.62825	33
+ 7′	9.79227	.61983	9.79376	.62195	9.79523	.62406	9.79670	.62618	9.79816	.62829	32
29	.79230	.61987	.79378	.62198	.79525	.62410	.79672	.62621	.79818	.62832	31
30	.79232	.61990	.79380	.62202	.79528	.62413	.79674	.62625	.79821	.62836	30
31	.79235	.61994	.79383	.62205	.79530	.62417	.79677	.62628	.79823	.62839	29
+ 8′	9.79237	.61997	9.79385	.62209	9.79533	.62420	9.79679	.62632	9.79825	.62843	28
33	.79240	.62001	.79388	.62213	.79535	.62424	.79682	.62635	.79828	.62846	27
34	.79242	.62004	.79390	.62216	.79538	.62427	.79684	.62639	.79830	.62850	26
35	.79245	.62008	.79393	.62220	.79540	.62431	.79687	.62642	.79833	.62853	25
+ 9′	9.79247	.62011	9.79395	.62223	9.79542	.62434	9.79689	.62646	9.79835	.62857	24
37	.79250	.62015	.79398	.62227	.79545	.62438	.79692	.62649	.79838	.62860	23
38	.79252	.62018	.79400	.62230	.79547	.62442	.79694	.62653	.79840	.62864	22
39	.79255	.62022	.79403	.62234	.79550	.62445	.79696	.62656	.79842	.62867	21
+ 10′	9.79257	.62026	9.79405	.62237	9.79552	.62449	9.79699	.62660	9.79845	.62871	20
41	.79260	.62029	.79407	.62241	.79555	.62452	.79701	.62663	.79847	.62874	19
42	.79262	.62033	.79410	.62244	.79557	.62456	.79704	.62667	.79850	.62878	18
43	.79264	.62036	.79412	.62248	.79560	.62459	.79706	.62670	.79852	.62881	17
+ 11′	9.79267	.62040	9.79415	.62251	9.79562	.62463	9.79709	.62674	9.79855	.62885	16
45	.79269	.62043	.79417	.62255	.79565	.62466	.79711	.62677	.79857	.62888	15
46	.79272	.62047	.79420	.62258	.79567	.62470	.79714	.62681	.79859	.62892	14
47	.79274	.62050	.79422	.62262	.79569	.62473	.79716	.62684	.79862	.62895	13
+ 12′	9.79277	.62054	9.79425	.62265	9.79572	.62477	9.79718	.62688	9.79864	.62899	12
49	.79279	.62057	.79427	.62269	.79574	.62480	.79721	.62691	.79867	.62902	11
50	.79282	.62061	.79430	.62272	.79577	.62484	.79723	.62695	.79869	.62906	10
51	.79284	.62064	.79432	.62276	.79579	.62487	.79726	.62698	.79872	.62909	9
+ 13′	9.79287	.62068	9.79434	.62279	9.79582	.62491	9.79728	.62702	9.79874	.62913	8
53	.79289	.62071	.79437	.62283	.79584	.62494	.79731	.62706	.79876	.62916	7
54	.79292	.62075	.79439	.62287	.79587	.62498	.79733	.62709	.79879	.62920	6
55	.79294	.62078	.79442	.62290	.79589	.62501	.79735	.62713	.79881	.62923	5
+ 14′	9.79297	.62082	9.79444	.62294	9.79591	.62505	9.79738	.62716	9.79884	.62927	4
57	.79299	.62085	.79447	.62297	.79594	.62508	.79740	.62720	.79886	.62930	3
58	.79301	.62089	.79449	.62301	.79596	.62512	.79743	.62723	.79888	.62934	2
59	.79304	.62093	.79452	.62304	.79599	.62515	.79745	.62727	.79891	.62937	1
+ 15′	9.79306	.62096	9.79454	.62308	9.79601	.62519	9.79748	.62730	9.79893	.62941	0
	$17^h\ 4^m$		$17^h\ 3^m$		$17^h\ 2^m$		$17^h\ 1^m$		$17^h\ 0^m$		

TABLE 45.

Haversines.

s	7h 0m 105° 0′		7h 1m 105° 15′		7h 2m 105° 30′		7h 3
	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. H
0	9.79893	.62941	9.80038	.63152	9.80183	.63362	9.803
1	.79896	.62944	.80041	.63155	.80185	.63365	.803
2	.79898	.62948	.80043	.63159	.80188	.63369	.803
3	.79901	.62951	.80046	.63162	.80190	.63372	.803
+ 1′	9.79903	.62955	9.80048	.63166	9.80192	.63376	9.803
5	.79905	.62958	.80050	.63169	.80195	.63379	.803
6	.79908	.62962	.80053	.63173	.80197	.63383	.803
7	.79910	.62965	.80055	.63176	.80200	.63386	.803
+ 2′	9.79913	.62969	9.80058	.63180	9.80202	.63390	9.803
9	.79915	.62973	.80060	.63183	.80204	.63393	.803
10	.79918	.62976	.80063	.63187	.80207	.63397	.803
11	.79920	.62980	.80065	.63190	.80209	.63400	.803
+ 3′	9.79922	.62983	9.80067	.63194	9.80212	.63404	9.803
13	.79925	.62987	.80070	.63197	.80214	.63407	.803
14	.79927	.62990	.80072	.63201	.80216	.63411	.803
15	.79930	.62994	.80075	.63204	.80219	.63414	.803
+ 4′	9.79932	.62997	9.80077	.63208	9.80221	.63418	9.803
17	.79935	.63001	.80079	.63211	.80224	.63421	.803
18	.79937	.63004	.80082	.63215	.80226	.63425	.803
19	.79939	.63008	.80084	.63218	.80228	.63428	.803
+ 5′	9.79942	.63011	9.80087	.63222	9.80231	.63432	9.803
21	.79944	.63015	.80089	.63225	.80233	.63435	.803
22	.79947	.63018	.80091	.63229	.80236	.63439	.803
23	.79949	.63022	.80094	.63232	.80238	.63442	.803
+ 6′	9.79951	.63025	9.80096	.63236	9.80240	.63446	9.803
25	.79954	.63029	.80099	.63239	.80243	.63450	.803
26	.79956	.63032	.80101	.63243	.80245	.63453	.803
27	.79959	.63036	.80103	.63246	.80248	.63457	.803
+ 7′	9.79961	.63039	9.80106	.63250	9.80250	.63460	9.803
29	.79964	.63043	.80108	.63253	.80252	.63464	.803
30	.79966	.63046	.80111	.63257	.80255	.63467	.803
31	.79968	.63050	.80113	.63260	.80257	.63471	.804
+ 8′	9.79971	.63053	9.80116	.63264	9.80260	.63474	9.804
33	.79973	.63057	.80118	.63267	.80262	.63478	.804
34	.79976	.63060	.80120	.63271	.80264	.63481	.804
35	.79978	.63064	.80123	.63274	.80267	.63485	.804
+ 9′	9.79980	.63067	9.80125	.63278	9.80269	.63488	9.804
37	.79983	.63071	.80128	.63281	.80272	.63492	.804
38	.79985	.63074	.80130	.63285	.80274	.63495	.804
39	.79988	.63078	.80132	.63288	.80276	.63499	.804
+ 10′	9.79990	.63081	9.80135	.63292	9.80279	.63502	9.804
41	.79993	.63085	.80137	.63295	.80281	.63506	.804
42	.79995	.63088	.80140	.63299	.80284	.63509	.804
43	.79997	.63092	.80142	.63302	.80286	.63513	.804
+ 11′	9.80000	.63095	9.80144	.63306	9.80288	.63516	9.804
45	.80002	.63099	.80147	.63309	.80291	.63520	.804
46	.80005	.63102	.80149	.63313	.80293	.63523	.804
47	.80007	.63106	.80152	.63316	.80296	.63527	.804
+ 12′	9.80009	.63109	9.80154	.63320	9.80298	.63530	9.804
49	.80012	.63113	.80156	.63323	.80300	.63534	.804
50	.80014	.63116	.80159	.63327	.80303	.63537	.804
51	.80017	.63120	.80161	.63330	.80305	.63541	.804
+ 13′	9.80019	.63123	9.80164	.63334	9.80307	.63544	9.804
53	.80022	.63127	.80166	.63337	.80310	.63548	.804
54	.80024	.63131	.80168	.63341	.80312	.63551	.804
55	.80026	.63134	.80171	.63344	.80315	.63555	.804
+ 14′	9.80029	.63138	9.80173	.63348	9.80317	.63558	9.804
57	.80031	.63142	.80176	.63351	.80319	.63562	.804
58	.80034	.63145	.80178	.63355	.80322	.63565	.804
59	.80036	.63148	.80180	.63358	.80324	.63569	.804
+ 15′	9.80038	.63152	9.80183	.63362	9.80327	.63572	9.804
	16h 59m		16h 58m		16h 57m		

TABLE 45.

Haversines.

	7h 5m 106° 15′		7h 6m 106° 30′		7h 7m 106° 45′		7h 8m 107° 0′		7h 9m 107° 15′		
	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	s
0	9.80612	.63991	9.80754	.64201	9.80895	.64410	9.81036	.64619	9.81176	.64827	60
1	.80615	.63995	.80756	.64204	.80898	.64413	.81038	.64622	.81178	.64831	59
2	.80617	.63998	.80759	.64208	.80900	.64417	.81040	.64626	.81180	.64834	58
3	.80619	.64002	.80761	.64211	.80902	.64420	.81043	.64629	.81183	.64838	57
+ 1′	9.80622	.64005	9.80763	.64215	9.80905	.64424	9.81045	.64632	9.81185	.64841	56
5	.80624	.64009	.80766	.64218	.80907	.64427	.81047	.64636	.81187	.64844	55
6	.80626	.64012	.80768	.64222	.80909	.64431	.81050	.64639	.81190	.64848	54
7	.80629	.64016	.80771	.64225	.80912	.64434	.81052	.64643	.81192	.64851	53
+ 2′	9.80631	.64019	9.80773	.64229	9.80914	.64438	9.81054	.64646	9.81194	.64855	52
9	.80634	.64023	.80775	.64232	.80916	.64441	.81057	.64650	.81197	.64858	51
10	.80636	.64026	.80778	.64236	.80919	.64445	.81059	.64653	.81199	.64862	50
11	.80638	.64030	.80780	.64239	.80921	.64448	.81061	.64657	.81201	.64865	49
+ 3′	9.80641	.64033	9.80782	.64243	9.80923	.64452	9.81064	.64660	9.81204	.64869	48
13	.80643	.64037	.80785	.64246	.80926	.64455	.81066	.64664	.81206	.64872	47
14	.80645	.64040	.80787	.64250	.80928	.64459	.81068	.64667	.81208	.64876	46
15	.80648	.64044	.80789	.64253	.80930	.64462	.81071	.64671	.81211	.64879	45
+ 4′	9.80650	.64047	9.80792	.64257	9.80933	.64466	.81073	.64674	9.81213	.64883	44
17	.80652	.64051	.80794	.64260	.80935	.64469	.81075	.64678	.81215	.64886	43
18	.80655	.64054	.80796	.64264	.80937	.64472	.81078	.64681	.81217	.64890	42
19	.80657	.64058	.80799	.64267	.80940	.64476	.81080	.64685	.81220	.64893	41
+ 5′	9.80660	.64061	9.80801	.64270	9.80942	.64479	9.81082	.64688	9.81222	.64897	40
21	.80662	.64065	.80804	.64274	.80944	.64483	.81085	.64692	.81224	.64900	39
22	.80664	.64068	.80806	.64277	.80947	.64486	.81087	.64695	.81227	.64903	38
23	.80667	.64072	.80808	.64281	.80949	.64490	.81089	.64699	.81229	.64907	37
+ 6′	9.80669	.64075	9.80811	.64284	9.80952	.64493	9.81092	.64702	9.81231	.64910	36
25	.80671	.64079	.80813	.64288	.80954	.64497	.81094	.64705	.81234	.64914	35
26	.80674	.64082	.80815	.64291	.80956	.64500	.81096	.64709	.81236	.64917	34
27	.80676	.64086	.80818	.64295	.80959	.64504	.81099	.64712	.81238	.64921	33
+ 7′	9.80678	.64089	9.80820	.64298	9.80961	.64507	9.81101	.64716	9.81241	.64924	32
29	.80681	.64093	.80822	.64302	.80963	.64511	.81103	.64719	.81243	.64928	31
30	.80683	.64096	.80825	.64305	.80966	.64514	.81106	.64723	.81245	.64931	30
31	.80686	.64100	.80827	.64309	.80968	.64518	.81108	.64726	.81248	.64935	29
+ 8′	9.80688	.64103	9.80829	.64312	9.80970	.64521	9.81110	.64730	9.81250	.64938	28
33	.80690	.64107	.80832	.64316	.80973	.64525	.81113	.64733	.81252	.64942	27
34	.80693	.64110	.80834	.64319	.80975	.64528	.81115	.64737	.81255	.64945	26
35	.80695	.64114	.80836	.64323	.80977	.64532	.81117	.64740	.81257	.64949	25
+ 9′	9.80697	.64117	9.80839	.64326	9.80980	.64535	9.81120	.64744	9.81259	.64952	24
37	.80700	.64121	.80841	.64330	.80982	.64539	.81122	.64747	.81262	.64956	23
38	.80702	.64124	.80844	.64333	.80984	.64542	.81124	.64751	.81264	.64959	22
39	.80704	.64128	.80846	.64337	.80987	.64546	.81127	.64754	.81266	.64962	21
+ 10′	9.80707	.64131	9.80848	.64340	9.80989	.64549	9.81129	.64758	9.81269	.64966	20
41	.80709	.64135	.80851	.64344	.80991	.64552	.81131	.64761	.81271	.64969	19
42	.80712	.64138	.80853	.64347	.80994	.64556	.81134	.64765	.81273	.64973	18
43	.80714	.64142	.80855	.64351	.80996	.64559	.81136	.64768	.81276	.64976	17
+ 11′	9.80716	.64145	9.80858	.64354	9.80998	.64563	9.81138	.64772	9.81278	.64980	16
45	.80719	.64148	.80860	.64358	.81001	.64566	.81141	.64775	.81280	.64983	15
46	.80721	.64152	.80862	.64361	.81003	.64570	.81143	.64778	.81282	.64987	14
47	.80723	.64155	.80865	.64365	.81005	.64573	.81145	.64782	.81285	.64990	13
+ 12′	9.80726	.64159	9.80867	.64368	9.81008	.64577	9.81148	.64785	9.81287	.64994	12
49	.80728	.64162	.80869	.64372	.81010	.64580	.81150	.64789	.81289	.64997	11
50	.80730	.64166	.80872	.64375	.81012	.64584	.81152	.64792	.81292	.65001	10
51	.80733	.64169	.80874	.64378	.81015	.64587	.81155	.64796	.81294	.65004	9
+ 13′	9.80735	.64173	9.80876	.64382	9.81017	.64591	9.81157	.64799	9.81296	.65008	8
53	.80738	.64176	.80879	.64385	.81019	.64594	.81159	.64803	.81299	.65011	7
54	.80740	.64180	.80881	.64389	.81022	.64598	.81162	.64806	.81301	.65014	6
55	.80742	.64183	.80883	.64392	.81024	.64601	.81164	.64810	.81303	.65018	5
+ 14′	9.80745	.64187	9.80886	.64396	9.81026	.64605	9.81166	.64813	9.81306	.65021	4
57	.80747	.64190	.80888	.64399	.81029	.64608	.81169	.64817	.81308	.65025	3
58	.80749	.64194	.80891	.64403	.81031	.64612	.81171	.64820	.81310	.65028	2
59	.80752	.64197	.80893	.64406	.81033	.64615	.81173	.64824	.81313	.65032	1
+ 15′	9.80754	.64201	9.80895	.64410	9.81036	.64619	9.81176	.64827	9.81315	.65035	0
	16h 54m		16h 53m		16h 52m		16h 51m		16h 50m		

TABLE 45.

Haversines.

	$7^h\ 10^m$ 107° 30′		$7^h\ 11^m$ 107° 45′		$7^h\ 12^m$ 108° 0′		7^h 1
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log.
0	9.81315	.65035	9.81454	.65243	9.81592	.65451	9.81
1	.81317	.65039	.81456	.65247	.81594	.65454	.81
2	.81320	.65042	.81458	.65250	.81596	.65458	.81
3	.81322	.65046	.81460	.65254	.81598	.65461	.81
+ 1′	9.81324	.65049	9.81463	.65257	9.81601	.65465	9.81
5	.81326	.65053	.81465	.65261	.81603	.65468	.81
6	.81329	.65056	.81467	.65264	.81605	.65472	.81
7	.81331	.65060	.81470	.65267	.81608	.65475	.81
+ 2′	9.81333	.65063	9.81472	.65271	9.81610	.65479	9.81
9	.81336	.65067	.81474	.65274	.81612	.65482	.81
10	.81338	.65070	.81477	.65278	.81614	.65485	.81
11	.81340	.65073	.81479	.65281	.81617	.65489	.81
+ 3′	9.81343	.65077	9.81481	.65285	9.81619	.65492	9.81
13	.81345	.65080	.81483	.65288	.81621	.65496	.81
14	.81347	.65084	.81486	.65292	.81624	.65499	.81
15	.81350	.65087	.81488	.65295	.81626	.65503	.81
+ 4′	9.81352	.65091	9.81490	.65299	9.81628	.65506	9.81
17	.81354	.65094	.81493	.65302	.81631	.65510	.81
18	.81357	.65098	.81495	.65306	.81633	.65513	.81
19	.81359	.65101	.81497	.65309	.81635	.65516	.81
+ 5′	9.81361	.65165	9.81500	.65312	9.81637	.65520	9.81
21	.81364	.65108	.81502	.65316	.81640	.65523	.81
22	.81366	.65112	.81505	.65319	.81642	.65527	.81
23	.81368	.65115	.81507	.65323	.81644	.65530	.81
+ 6′	9.81370	.65118	9.81509	.65326	9.81647	.65534	9.81
25	.81373	.65122	.81511	.65330	.81649	.65537	.81
26	.81375	.65125	.81513	.65333	.81651	.65541	.81
27	.81377	.65129	.81516	.65337	.81653	.65544	.81
+ 7′	9.81380	.65132	9.81518	.65340	9.81656	.65548	9.81
29	.81382	.65136	.81520	.65344	.81658	.65551	.81
30	.81384	.65139	.81523	.65347	.81660	.65555	.81
31	.81387	.65143	.81525	.65351	.81663	.65558	.81
+ 8′	9.81389	.65146	9.81527	.65354	9.81665	.65561	9.81
33	.81391	.65150	.81530	.65357	.81667	.65565	.81
34	.81394	.65153	.81532	.65361	.81669	.65568	.81
35	.81396	.65157	.81534	.65364	.81672	.65572	.81
+ 9′	9.81398	.65160	9.81536	.65368	9.81674	.65575	9.81
37	.81400	.65164	.81539	.65372	.81676	.65579	.81
38	.81403	.65167	.81541	.65375	.81679	.65582	.81
39	.81405	.65171	.81543	.65378	.81681	.65586	.81
+ 10′	9.81407	.65174	9.81546	.65382	9.81683	.65589	9.81
41	.81410	.65177	.81548	.65385	.81685	.65593	.81
42	.81412	.65181	.81550	.65389	.81688	.65596	.81
43	.81414	.65184	.81552	.65392	.81690	.65599	.81
+ 11′	9.81417	.65188	9.81555	.65396	9.81692	.65603	.81
45	.81419	.65191	.81557	.65399	.81695	.65606	.81
46	.81421	.65195	.81559	.65402	.81697	.65610	.81
47	.81424	.65198	.81562	.65406	.81699	.65613	.81
+ 12′	9.81426	.65202	9.81564	.65409	9.81701	.65617	9.81
49	.81428	.65205	.81566	.65413	.81704	.65620	.81
50	.81430	.65209	.81569	.65416	.81706	.65624	.81
51	.81433	.65212	.81571	.65420	.81708	.65627	.81
+ 13′	9.81435	.65216	9.81573	.65423	9.81711	.65630	9.81
53	.81437	.65219	.81575	.65427	.81713	.65534	.81
54	.81440	.65222	.81578	.65430	.81715	.65637	.81
55	.81442	.65226	.81580	.65434	.81717	.65641	.81
+ 14′	9.81444	.65229	9.81582	.65437	9.81720	.65644	9.81
57	.81447	.65233	.81585	.65440	.81722	.55648	.81
58	.81449	.65236	.81587	.65444	.81724	.65651	.81
59	.81451	.65240	.81589	.65447	.81727	.65655	.81
+ 15′	9.81454	.65243	9.81592	.65451	9.81729	.65658	9.81
	$16^h\ 49^m$		$16^h\ 48^m$		$16^h\ 47^m$		

TABLE 45.

Haversines.

s	7h 15m 108° 45′		7h 16m 109° 0′		7h 17m 109° 15′		7h 18m 109° 30′		7h 19m 109° 45′		s
	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	
0	9.82002	.66072	9.82137	.66278	9.82272	.66485	9.82406	.66690	9.82540	.66896	60
1	.82004	.66075	.82139	.66282	.82274	.66488	.82409	.66694	.82542	.66899	59
2	.82006	.66079	.82142	.66285	.82277	.66491	.82411	.66697	.82544	.66903	58
3	.82009	.66082	.82144	.66289	.82279	.66495	.82413	.66701	.82547	.66906	57
+ 1′	9.82011	.66086	9.82146	.66292	9.82281	.66498	9.82415	.66704	9.82549	.66910	56
5	.82013	.66089	.82148	.66296	.82283	.66502	.82417	.66707	.82551	.66913	55
6	.82015	.66093	.82151	.66299	.82286	.66505	.82420	.66711	.82553	.66916	54
7	.82018	.66096	.82153	.66302	.82288	.66509	.82422	.66714	.82555	.66920	53
+ 2′	9.82020	.66100	9.82155	.66306	9.82290	.66512	9.82424	.66718	9.82558	.66923	52
9	.82022	.66103	.82157	.66309	.82292	.66515	.82426	.66721	.82560	.66927	51
10	.82024	.66106	.82160	.66313	.82294	.66519	.82429	.66725	.82562	.66930	50
11	.82027	.66110	.82162	.66316	.82297	.66522	.82431	.66728	.82564	.66933	49
+ 3′	9.82029	.66113	9.82164	.66320	9.82299	.66526	9.82433	.66731	9.82567	.66937	48
13	.82031	.66117	.82166	.66323	.82301	.66529	.82435	.66735	.82569	.66940	47
14	.82033	.66120	.82169	.66327	.82303	.66533	.82438	.66738	.82571	.66944	46
15	.82036	.66124	.82171	.66330	.82306	.66536	.82440	.66742	.82573	.66947	45
+ 4′	9.82038	.66127	9.82173	.66333	9.82308	.66539	9.82442	.66745	9.82575	.66951	44
17	.82040	.66130	.82175	.66337	.82310	.66543	.82444	.66749	.82578	.66954	43
18	.82042	.66134	.82178	.66340	.82312	.66546	.82446	.66752	.82580	.66957	42
19	.82045	.66137	.82180	.66344	.82315	.66550	.82449	.66755	.82582	.66961	41
+ 5′	9.82047	.66141	9.82182	.66347	9.82317	.66553	9.82451	.66759	9.82584	.66964	40
21	.82049	.66144	.82184	.66351	.82319	.66557	.82453	.66762	.82587	.66968	39
22	.82051	.66148	.82187	.66354	.82321	.66560	.82455	.66766	.82589	.66971	38
23	.82054	.66151	.82189	.66357	.82324	.66563	.82458	.66769	.82591	.66975	37
+ 6′	9.82056	.66155	9.82191	.66361	9.82326	.66567	9.82460	.66773	9.82593	.66978	36
25	.82058	.66158	.82193	.66364	.82328	.66570	.82462	.66776	.82595	.66981	35
26	.82061	.66161	.82196	.66368	.82330	.66574	.82464	.66779	.82598	.66985	34
27	.82063	.66165	.82198	.66371	.82333	.66577	.82467	.66783	.82600	.66988	33
+ 7′	9.82065	.66168	9.82200	.66375	9.82335	.66581	9.82469	.66786	9.82602	.66992	32
29	.82067	.66172	.82202	.66378	.82337	.66584	.82471	.66790	.82604	.66995	31
30	.82070	.66175	.82205	.66382	.82339	.66587	.82473	.66793	.82606	.66998	30
31	.82072	.66179	.82207	.66385	.82341	.66591	.82475	.66797	.82609	.67002	29
+ 8′	9.82074	.66182	9.82209	.66388	9.82344	.66594	9.82478	.66800	9.82611	.67005	28
33	.82076	.66186	.82211	.66392	.82346	.66598	.82480	.66803	.82613	.67009	27
34	.82079	.66189	.82214	.66395	.82348	.66601	.82482	.66807	.82615	.67012	26
35	.82081	.66192	.82216	.66399	.82350	.66605	.82484	.66810	.82618	.67016	25
+ 9′	9.82083	.66196	9.82218	.66402	9.82353	.66608	9.82487	.66814	9.82620	.67019	24
37	.82085	.66199	.82220	.66406	.82355	.66611	.82489	.66817	.82622	.67022	23
38	.82088	.66203	.82223	.66409	.82357	.66615	.82491	.66821	.82624	.67026	22
39	.82090	.66206	.82225	.66412	.82359	.66618	.82493	.66824	.82627	.67029	21
+ 10′	9.82092	.66210	9.82227	.66416	9.82362	.66622	9.82495	.66827	9.82629	.67033	20
41	.82094	.66213	.82229	.66419	.82364	.66625	.82498	.66831	.82631	.67036	19
42	.82097	.66217	.82232	.66423	.82366	.66629	.82500	.66834	.82633	.67039	18
43	.82099	.66220	.82234	.66426	.82368	.66632	.82502	.66838	.82635	.67043	17
+ 11′	9.82101	.66223	9.82236	.66430	9.82371	.66635	9.82504	.66841	9.82638	.67046	16
45	.82103	.66227	.82238	.66433	.82373	.66639	.82507	.66844	.82640	.67050	15
46	.82106	.66230	.82241	.66436	.82375	.66642	.82509	.66848	.82642	.67053	14
47	.82108	.66234	.82243	.66440	.82377	.66646	.82511	.66851	.82644	.67057	13
+ 12′	9.82110	.66237	9.82245	.66443	9.82380	.66649	9.82513	.66855	9.82646	.67060	12
49	.82112	.66241	.82247	.66447	.82382	.66653	.82515	.66858	.82649	.67063	11
50	.82115	.66244	.82250	.66450	.82384	.66656	.82518	.66862	.82651	.67067	10
51	.82117	.66247	.82252	.66454	.82386	.66659	.82520	.66865	.82653	.67070	9
+ 13′	9.82119	.66251	9.82254	.66457	9.82388	.66663	9.82522	.66868	9.82655	.67074	8
53	.82121	.66254	.82256	.66461	.82391	.66666	.82524	.66872	.82657	.67077	7
54	.82124	.66258	.82259	.66464	.82393	.66670	.82527	.66875	.82660	.67081	6
55	.82126	.66261	.82261	.66467	.82395	.66673	.82529	.66879	.82662	.67084	5
+ 14′	9.82128	.66265	9.82263	.66471	9.82397	.66677	9.82531	.66882	9.82664	.67087	4
57	.82130	.66268	.82265	.66474	.82400	.66680	.82533	.66886	.82666	.67091	3
58	.82133	.66272	.82268	.66478	.82402	.66683	.82535	.66889	.82668	.67094	2
59	.82135	.66275	.82270	.66481	.82404	.66687	.82538	.66892	.82671	.67098	1
+ 15′	9.82137	.66278	9.82272	.66485	9.82406	.66690	9.82540	.66896	9.82673	.67101	0
	16h 44m		16h 43m		16h 42m		16h 41m		16h 40m		

TABLE 45.

Haversines.

	$7^h\ 20^m$ 110° 0′		$7^h\ 21^m$ 110° 15′		$7^h\ 22^m$ 110° 30′		$7^h\ 2$
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. H
0	9.82673	.67101	9.82805	.67306	9.82937	.67510	9.830
1	.82675	.67104	.82807	.67309	.82939	.67514	.830
2	.82677	.67108	.82810	.67313	.82941	.67517	.830
3	.82680	.67111	.82812	.67316	.82944	.67521	.830
+ 1′	9.82682	.67115	9.82814	.67320	9.82946	.67524	9.830
5	.82684	.67118	.82816	.67323	.82948	.67527	.830
6	.82686	.67122	.82818	.67326	.82950	.67531	.830
7	.82688	.67125	.82821	.67330	.82952	.67534	.830
+ 2′	9.82691	.67128	9.82823	.67333	9.82955	.67538	9.830
9	.82693	.67132	.82825	.67337	.82957	.67541	.830
10	.82695	.67135	.82827	.67340	.82959	.67544	.830
11	.82697	.67139	.82829	.67343	.82961	.67548	.830
+ 3′	9.82699	.67142	9.82832	.67347	9.82963	.67551	9.830
13	.82702	.67145	.82834	.67350	.82966	.67555	.830
14	.82704	.67149	.82836	.67354	.82968	.67558	.830
15	.82706	.67152	.82838	.67357	.82970	.67561	.831
+ 4′	9.82708	.67156	9.82840	.67360	9.82972	.67565	9.831
17	.82710	.67159	.82843	.67364	.82974	.67568	.831
18	.82713	.67163	.82845	.67367	.82976	.67572	.831
19	.82715	.67166	.82847	.67371	.82979	.67575	.831
+ 5′	9.82717	.67169	9.82849	.67374	9.82981	.67578	9.831
21	.82719	.67173	.82851	.67377	.82983	.67582	.831
22	.82722	.67176	.82854	.67381	.82985	.67585	.831
23	.82724	.67180	.82856	.67384	.82987	.67589	.831
+ 6′	9.82726	.67183	9.82858	.67388	9.82990	.67592	9.831
25	.82728	.67186	.82860	.67391	.82992	.67595	.831
26	.82730	.67190	.82862	.67395	.82994	.67599	.831
27	.82733	.67193	.82865	.67398	.82996	.67602	.831
+ 7′	9.82735	.67197	9.82867	.67401	9.82998	.67606	9.831
29	.82737	.67200	.82869	.67405	.83001	.67609	.831
30	.82739	.67203	.82871	.67408	.83003	.67613	.831
31	.82741	.67207	.82873	.67412	.83005	.67616	.831
+ 8′	9.82744	.67210	9.82876	.67415	9.83007	.67619	9.831
33	.82746	.67214	.82878	.67418	.83009	.67623	.831
34	.82748	.67217	.82880	.67422	.83011	.67626	.831
35	.82750	.67221	.82882	.67425	.83014	.67630	.831
+ 9′	9.82752	.67224	9.82884	.67429	9.83016	.67633	9.831
37	.82755	.67227	.82887	.67432	.83018	.67636	.831
38	.82757	.67231	.82889	.67435	.83020	.67640	.831
39	.82759	.67234	.82891	.67439	.83022	.67643	.831
+ 10′	9.82761	.67238	9.82893	.67442	9.83025	.67647	9.831
41	.82763	.67241	.82895	.67446	.83027	.67650	.831
42	.82766	.67244	.82898	.67449	.83029	.67653	.831
43	.82768	.67248	.82900	.67452	.83031	.67657	.831
+ 11′	9.82770	.67251	9.82902	.67456	9.83033	.67660	9.831
45	.82772	.67255	.82904	.67459	.83035	.67664	.831
46	.82774	.67258	.82906	.67463	.83038	.67667	.831
47	.82777	.67261	.82909	.67466	.83040	.67670	.831
+ 12′	9.82779	.67265	9.82911	.67469	9.83042	.67674	9.831
49	.82781	.67268	.82913	.67473	.83044	.67677	.831
50	.82783	.67272	.82915	.67476	.83046	.67681	.831
51	.82785	.67275	.82917	.67480	.83049	.67684	.831
+ 13′	9.82788	.67279	9.82920	.67483	9.83051	.67687	9.831
53	.82790	.67282	.82922	.67487	.83053	.67691	.831
54	.82792	.67285	.82924	.67490	.83055	.67694	.831
55	.82794	.67289	.82926	.67493	.83057	.67698	.831
+ 14′	9.82796	.67292	9.82928	.67497	9.83059	.67701	9.831
57	.82799	.67296	.82930	.67500	.83062	.67704	.831
58	.82801	.67299	.82933	.67504	.83064	.67708	.831
59	.82803	.67302	.82935	.67507	.83066	.67711	.831
+ 15′	9.82805	.67306	9.82937	.67510	9.83068	.67715	9.831
	$16^h\ 39^m$		$16^h\ 38^m$		$16^h\ 37^m$		

TABLE 45.

Haversines.

	7^h 25^m 111° 15′		7^h 26^m 111° 30′		7^h 27^m 111° 45′		7^h 28^m 112° 0′		7^h 29^m 112° 15′		
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	s
0	9.83329	.68122	9.83458	.68325	9.83587	.68528	9.83715	.68730	9.83842	.68932	60
1	.83331	.68125	.83460	.68328	.83589	.68531	.83717	.68734	.83844	.68936	59
2	.83333	.68129	.83462	.68332	.83591	.68535	.83719	.68737	.83847	.68939	58
3	.83335	.68132	.83464	.68335	.83593	.68538	.83721	.68740	.83849	.68943	57
+ 1′	9.83337	.68135	9.83467	.68339	9.83595	.68541	9.83723	.68744	9.83851	.68946	56
5	.83339	.68139	.83469	.68342	.83597	.68545	.83725	.68747	.83853	.68949	55
6	.83342	.68142	.83471	.68345	.83600	.68548	.83728	.68751	.83855	.68953	54
7	.83344	.68146	.83473	.68349	.83602	.68552	.83730	.68754	.83857	.68956	53
+ 2′	9.83346	.68149	9.83475	.68352	9.83604	.68555	9.83732	.68757	9.83859	.68959	52
9	.83348	.68152	.83477	.68356	.83606	.68558	.83734	.68761	.83861	.68963	51
10	.83350	.68156	.83480	.68359	.83608	.68562	.83736	.68764	.83864	.68966	50
11	.83352	.68159	.83482	.68362	.83610	.68565	.83738	.68767	.83866	.68969	49
+ 3′	9.83355	.68163	9.83484	.68366	9.83612	.68568	9.83740	.68771	9.83868	.68973	48
13	.83357	.68166	.83486	.68369	.83615	.68572	.83743	.68774	.83870	.68976	47
14	.83359	.68169	.83488	.68372	.83617	.68575	.83745	.68778	.83872	.68980	46
15	.83361	.68173	.83490	.68376	.83619	.68579	.83747	.68781	.83874	.68983	45
+ 4′	9.83363	.68176	9.83492	.68379	9.83621	.68582	9.83749	.68784	9.83876	.68986	44
17	.83365	.68180	.83495	.68383	.83623	.68585	.83751	.68788	.83878	.68990	43
18	.83368	.68183	.83497	.68386	.83625	.68589	.83753	.68791	.83881	.68993	42
19	.83370	.68186	.83499	.68389	.83627	.68592	.83755	.68794	.83883	.68996	41
+ 5′	9.83372	.68190	9.83501	.68393	9.83630	.68595	9.83757	.68798	9.83885	.69000	40
21	.83374	.68193	.83503	.68396	.83632	.68599	.83760	.68801	.83887	.69003	39
22	.83376	.68196	.83505	.68399	.83634	.68602	.83762	.68804	.83889	.69006	38
23	.83378	.68200	.83507	.68403	.83636	.68606	.83764	.68808	.83891	.69010	37
+ 6′	9.83380	.68203	9.83510	.68406	9.83638	.68609	9.83766	.68811	9.83893	.69013	36
25	.83383	.68207	.83512	.68410	.83640	.68612	.83768	.68815	.83895	.69017	35
26	.83385	.68210	.83514	.68413	.83642	.68616	.83770	.68818	.83897	.69020	34
27	.83387	.68213	.83516	.68416	.83644	.68619	.83772	.68821	.83900	.69023	33
+ 7′	9.83389	.68217	9.83518	.68420	9.83647	.68622	9.83774	.68825	9.83902	.69027	32
29	.83391	.68220	.83520	.68423	.83649	.68626	.83777	.68828	.83904	.69030	31
30	.83393	.68224	.83522	.68427	.83651	.68629	.83779	.68831	.83906	.69033	30
31	.83396	.68227	.83525	.68430	.83653	.68633	.83781	.68835	.83908	.69037	29
+ 8′	9.83398	.68230	9.83527	.68433	9.83655	.68636	9.83783	.68838	9.83910	.69040	28
33	.83400	.68234	.83529	.68437	.83657	.68639	.83785	.68842	.83912	.69043	27
34	.83402	.68237	.83531	.68440	.83659	.68643	.83787	.68845	.83914	.69047	26
35	.83404	.68240	.83533	.68443	.83662	.68646	.83789	.68848	.83916	.69050	25
+ 9′	9.83406	.68244	9.83535	.68447	9.83664	.68649	9.83791	.68852	9.83919	.69054	24
37	.83409	.68247	.83537	.68450	.83666	.68653	.83794	.68855	.83921	.69057	23
38	.83411	.68251	.83540	.68454	.83668	.68656	.83796	.68858	.83923	.69060	22
39	.83413	.68254	.83542	.68457	.83670	.68660	.83798	.68862	.83925	.69064	21
+ 10′	9.83415	.68257	9.83544	.68460	9.83672	.68663	9.83800	.68865	9.83927	.69067	20
41	.83417	.68261	.83546	.68464	.83674	.68666	.83802	.68868	.83929	.69070	19
42	.83419	.68264	.83548	.68467	.83676	.68670	.83804	.68872	.83931	.69074	18
43	.83421	.68268	.83550	.68470	.83679	.68673	.83806	.68875	.83933	.69077	17
+ 11′	9.83424	.68271	9.83552	.68474	9.83681	.68676	9.83808	.68879	9.83935	.69080	16
45	.83426	.68274	.83555	.68477	.83683	.68680	.83811	.68882	.83938	.69084	15
46	.83428	.68278	.83557	.68481	.83685	.68683	.83813	.68885	.83940	.69087	14
47	.83430	.68281	.83559	.68484	.83687	.68687	.83815	.68889	.83942	.69091	13
+ 12′	9.83432	.68284	9.83561	.68487	9.83689	.68690	9.83817	.68892	9.83944	.69094	12
49	.83434	.68288	.83563	.68491	.83691	.68693	.83819	.68895	.83946	.69097	11
50	.83436	.68291	.83565	.68494	.83694	.68697	.83821	.68899	.83948	.69101	10
51	.83439	.68295	.83567	.68497	.83696	.68700	.83823	.68902	.83950	.69104	9
+ 13′	9.83441	.68298	9.83570	.68501	9.83698	.68703	9.83825	.68905	9.83952	.69107	8
53	.83443	.68301	.83572	.68504	.83700	.68707	.83828	.68909	.83955	.69111	7
54	.83445	.68305	.83574	.68508	.83702	.68710	.83830	.68912	.83957	.69114	6
55	.83447	.68308	.83576	.68511	.83704	.68713	.83832	.68916	.83959	.69117	5
+ 14′	9.83449	.68312	9.83578	.68515	9.83706	.68717	9.83834	.68919	9.83961	.69121	4
57	.83452	.68315	.83580	.68518	.83708	.68720	.83836	.68922	.83963	.69124	3
58	.83454	.68318	.83582	.68521	.83711	.68724	.83838	.68926	.83965	.69127	2
59	.83456	.68322	.83585	.68525	.83713	.68727	.83840	.68929	.83967	.69131	1
+ 15′	9.83458	.68325	9.83587	.68528	9.83715	.68730	9.83842	.68932	9.83969	.69134	0
	16^h 34^m		16^h 33^m		16^h 32^m		16^h 31^m		16^h 30^m		

TABLE 45.

Haversines.

	$7^h\,30^m$ 112° 30′		$7^h\,31^m$ 112° 45′		$7^h\,32^m$ 113° 0′		$7^h\,3$
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. H
0	9.83969	.69134	9.84096	.69336	9.84221	.69537	9.843
1	.83971	.69138	.84098	.69339	.84223	.69540	.843
2	.83974	.69141	.84100	.69342	.84226	.69543	.843
3	.83976	.69144	.84102	.69346	.84228	.69547	.843
+ 1′	9.83978	.69148	9.84104	.69349	9.84230	.69550	9.843
5	.83980	.69151	.84106	.69352	.84232	.69553	.843
6	.83982	.69154	.84108	.69356	.84234	.69557	.843
7	.83984	.69158	.84110	.69359	.84236	.69560	.843
+ 2′	9.83986	.69161	9.84112	.69362	9.84238	.69563	9.843
9	.83988	.69164	.84114	.69366	.84240	.69567	.843
10	.83990	.69168	.84117	.69369	.84242	.69570	.843
11	.83992	.69171	.84119	.69372	.84244	.69573	.843
+ 3′	9.83995	.69174	9.84121	.69376	9.84246	.69577	9.843
13	.83997	.69178	.84123	.69379	.84248	.69580	.843
14	.83999	.69181	.84125	.69382	.84251	.69583	.843
15	.84001	.69185	.84127	.69386	.84253	.69587	.843
+ 4′	9.84003	.69188	9.84129	.69389	9.84255	.69590	9.843
17	.84005	.69191	.84131	.69393	.84257	.69593	.843
18	.84007	.69195	.84133	.69396	.84259	.69597	.843
19	.84009	.69198	.84135	.69399	.84261	.69600	.843
+ 5′	9.84011	.69201	9.84138	.69403	9.84263	.69603	9.843
21	.84014	.69205	.84140	.69406	.84265	.69607	.843
22	.84016	.69208	.84142	.69409	.84267	.69610	.843
23	.84018	.69211	.84144	.69413	.84269	.69614	.843
+ 6′	9.84020	.69215	9.84146	.69416	9.84271	.69617	9.843
25	.84022	.69218	.84148	.69419	.84274	.69620	.843
26	.84024	.69221	.84150	.69423	.84276	.69624	.844
27	.84026	.69225	.84152	.69426	.84278	.69627	.844
+ 7′	9.84028	.69228	9.84154	.69429	9.84280	.69630	9.844
29	.84030	.69232	.84156	.69433	.84282	.69634	.844
30	.84033	.69235	.84159	.69436	.84284	.69637	.844
31	.84035	.69238	.84161	.69439	.84286	.69640	.844
+ 8′	9.84037	.69242	9.84163	.69443	9.84288	.69644	9.844
33	.84039	.69245	.84165	.69446	.84290	.69647	.844
34	.84041	.69248	.84167	.69450	.84292	.69650	.844
35	.84043	.69252	.84169	.69453	.84294	.69654	.844
+ 9′	9.84045	.69255	9.84171	.69456	9.84296	.69657	9.844
37	.84047	.69258	.84173	.69460	.84299	.69660	.844
38	.84049	.69262	.84175	.69463	.84301	.69664	.844
39	.84051	.69265	.84177	.69466	.84303	.69667	.844
+ 10′	9.84054	.69268	9.84179	.69470	9.84305	.69670	9.844
41	.84056	.69272	.84182	.69473	.84307	.69674	.844
42	.84058	.69275	.84184	.69476	.84309	.69677	.844
43	.84060	.69279	.84186	.69480	.84311	.69680	.844
+ 11′	9.84062	.69282	9.84188	.69483	9.84313	.69684	9.844
45	.84064	.69285	.84190	.69486	.84315	.69687	.844
46	.84066	.69289	.84192	.69490	.84317	.69690	.844
47	.84068	.69292	.84194	.69493	.84319	.69694	.844
+ 12′	9.84070	.69295	9.84196	.69496	9.84321	.69697	9.844
49	.84072	.69299	.84198	.69500	.84324	.69700	.844
50	.84075	.69302	.84200	.69503	.84326	.69704	.844
51	.84077	.69305	.84203	.69506	.84328	.69707	.844
+ 13′	9.84079	.69309	9.84205	.69510	9.84330	.69710	9.844
53	.84081	.69312	.84207	.69513	.84332	.69714	.844
54	.84083	.69315	.84209	.69516	.84334	.69717	.844
55	.84085	.69319	.84211	.69520	.84336	.69720	.844
+ 14′	9.84087	.69322	9.84213	.69523	9.84338	.69724	9.844
57	.84089	.69326	.84215	.69527	.84340	.69727	.844
58	.84091	.69329	.84217	.69530	.84342	.69731	.844
59	.84093	.69332	.84219	.69533	.84344	.69734	.844
+ 15′	9.84096	.69336	9.84221	.69537	9.84346	.69737	9.844
	$16^h\,29^m$		$16^h\,28^m$		$16^h\,27^m$		

TABLE 45.

Haversines.

	$7^h\ 35^m$ 113° 45′		$7^h\ 36^m$ 114° 0′		$7^h\ 37^m$ 114° 15′		$7^h\ 38^m$ 114° 30′		$7^h\ 39^m$ 114° 45′		
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	s
0	9.84595	.70137	9.84718	.70337	9.84841	.70536	9.84963	.70735	9.85085	.70933	60
1	.84597	.70141	.84720	.70340	.84843	.70539	.84965	.70738	.85087	.70936	59
2	.84599	.70144	.84722	.70343	.84845	.70543	.84967	.70741	.85089	.70940	58
3	.84601	.70147	.84724	.70347	.84847	.70546	.84969	.70745	.85091	.70943	57
+ 1′	9.84603	.70151	9.84726	.70350	9.84849	.70549	9.84971	.70748	9.85093	.70946	56
5	.84605	.70154	.84729	.70353	.84851	.70553	.84973	.70751	.85095	.70950	55
6	.84607	.70157	.84731	.70357	.84853	.70556	.84975	.70755	.85097	.70953	54
7	.84609	.70161	.84733	.70360	.84855	.70559	.84977	.70758	.85099	.70956	53
+ 2′	9.84611	.70164	9.84735	.70363	9.84857	.70562	9.84979	.70761	9.85101	.70959	52
9	.84613	.70167	.84737	.70367	.84859	.70566	.84982	.70764	.85103	.70963	51
10	.84616	.70171	.84739	.70370	.84861	.70569	.84984	.70768	.85105	.70966	50
11	.84618	.70174	.84741	.70373	.84863	.70572	.84986	.70771	.85107	.70969	49
+ 3′	9.84620	.70177	9.84743	.70377	9.84866	.70576	9.84988	.70774	9.85109	.70973	48
13	.84622	.70181	.84745	.70380	.84868	.70579	.84990	.70778	.85111	.70976	47
14	.84624	.70184	.84747	.70383	.84870	.70582	.84992	.70781	.85113	.70979	46
15	.84626	.70187	.84749	.70387	.84872	.70586	.84994	.70784	.85115	.70983	45
+ 4′	9.84628	.70191	9.84751	.70390	9.84874	.70589	9.84996	.70788	9.85117	.70986	44
17	.84630	.70194	.84753	.70393	.84876	.70592	.84998	.70791	.85119	.70989	43
18	.84632	.70197	.84755	.70397	.84878	.70596	.85000	.70794	.85121	.70992	42
19	.84634	.70201	.84757	.70400	.84880	.70599	.85002	.70798	.85123	.70996	41
+ 5′	9.84636	.70204	9.84759	.70403	9.84882	.70602	9.85004	.70801	9.85125	.70999	40
21	.84638	.70207	.84761	.70407	.84884	.70606	.85006	.70804	.85127	.71002	39
22	.84640	.70211	.84763	.70410	.84886	.70609	.85008	.70807	.85129	.71006	38
23	.84642	.70214	.84765	.70413	.84888	.70612	.85010	.70811	.85131	.71009	37
+ 6′	9.84644	.70217	9.84767	.70417	9.84890	.70615	9.85012	.70814	9.85133	.71012	36
25	.84646	.70221	.84770	.70420	.84892	.70619	.85014	.70817	.85135	.71016	35
26	.84648	.70224	.84772	.70423	.84894	.70622	.85016	.70821	.85137	.71019	34
27	.84651	.70227	.84774	.70426	.84896	.70625	.85018	.70824	.85139	.71022	33
+ 7′	9.84653	.70230	9.84776	.70430	9.84898	.70629	9.85020	.70827	9.85141	.71025	32
29	.84655	.70234	.84778	.70433	.84900	.70632	.85022	.70831	.85143	.71029	31
30	.84657	.70237	.84780	.70436	.84902	.70635	.85024	.70834	.85145	.71032	30
31	.84659	.70240	.84782	.70440	.84904	.70639	.85026	.70837	.85147	.71035	29
+ 8′	9.84661	.70244	9.84784	.70443	9.84906	.70642	9.85028	.70840	9.85149	.71039	28
33	.84663	.70247	.84786	.70446	.84908	.70645	.85030	.70844	.85151	.71042	27
34	.84665	.70250	.84788	.70450	.84910	.70649	.85032	.70847	.85153	.71045	26
35	.84667	.70254	.84790	.70453	.84912	.70652	.85034	.70850	.85155	.71049	25
+ 9′	9.84669	.70257	9.84792	.70456	9.84914	.70655	9.85036	.70854	9.85158	.71052	24
37	.84671	.70260	.84794	.70460	.84916	.70659	.85038	.70857	.85160	.71055	23
38	.84673	.70264	.84796	.70463	.84919	.70662	.85040	.70860	.85162	.71058	22
39	.84675	.70267	.84798	.70466	.84921	.70665	.85042	.70864	.85164	.71062	21
+ 10′	9.84677	.70270	9.84800	.70470	9.84923	.70668	9.85044	.70867	9.85166	.71065	20
41	.84679	.70274	.84802	.70473	.84925	.70672	.85046	.70870	.85168	.71068	19
42	.84681	.70277	.84804	.70476	.84927	.70675	.85048	.70874	.85170	.71072	18
43	.84683	.70280	.84806	.70480	.84929	.70678	.85050	.70877	.85172	.71075	17
+ 11′	9.84685	.70284	9.84808	.70483	9.84931	.70682	9.85052	.70880	9.85174	.71078	16
45	.84688	.70287	.84810	.70486	.84933	.70685	.85054	.70884	.85176	.71081	15
46	.84690	.70290	.84812	.70490	.84935	.70688	.85057	.70887	.85178	.71085	14
47	.84692	.70294	.84815	.70493	.84937	.70692	.85059	.70890	.85180	.71088	13
+ 12′	9.84694	.70297	9.84817	.70496	9.84939	.70695	9.85061	.70893	9.85182	.71091	12
49	.84696	.70300	.84819	.70499	.84941	.70698	.85063	.70897	.85184	.71095	11
50	.84698	.70304	.84821	.70503	.84943	.70702	.85065	.70900	.85186	.71098	10
51	.84700	.70307	.84823	.70506	.84945	.70705	.85067	.70903	.85188	.71101	9
+ 13′	9.84702	.70310	9.84825	.70509	9.84947	.70708	9.85069	.70907	9.85190	.71105	8
53	.84704	.70314	.84827	.70513	.84949	.70712	.85071	.70910	.85192	.71108	7
54	.84706	.70317	.84829	.70516	.84951	.70715	.85073	.70913	.85194	.71111	6
55	.84708	.70320	.84831	.70519	.84953	.70718	.85075	.70916	.85196	.71114	5
+ 14′	9.84710	.70324	9.84833	.70523	9.84955	.70721	9.85077	.70920	9.85198	.71118	4
57	.84712	.70327	.84835	.70526	.84957	.70725	.85079	.70923	.85200	.71121	3
58	.84714	.70330	.84837	.70529	.84959	.70728	.85081	.70926	.85202	.71124	2
59	.84716	.70333	.84839	.70533	.84961	.70731	.85083	.70930	.85204	.71128	1
+ 15′	9.84718	.70337	9.84841	.70536	9.84963	.70735	9.85085	.70933	9.85206	.71131	0
	$16^h\ 24^m$		$16^h\ 23^m$		$16^h\ 22^m$		$16^h\ 21^m$		$16^h\ 20^m$		

TABLE 45.

Haversines.

s	$7^{h}\,45^{m}$ 116° 15′		$7^{h}\,46^{m}$ 116° 30′		$7^{h}\,47^{m}$ 116° 45′		$7^{h}\,48^{m}$ 117° 0′		$7^{h}\,49^{m}$ 117° 15′		
s	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	s
0	9.85802	.72114	9.85920	.72310	9.86037	.72505	9.86153	.72700	9.86269	.72894	60
1	.85804	.72118	.85922	.72313	.86039	.72508	.86155	.72703	.86271	.72897	59
2	.85806	.72121	.85924	.72316	.86041	.72511	.86157	.72706	.86273	.72900	58
3	.85808	.72124	.85926	.72320	.86043	.72515	.86159	.72709	.86275	.72903	57
+ 1′	9.85810	.72127	9.85928	.72323	9.86045	.72518	9.86161	.72713	9.86277	.72907	56
5	.85812	.72131	.85930	.72326	.86046	.72521	.86163	.72716	.86279	.72910	55
6	.85814	.72134	.85931	.72330	.86048	.72524	.86165	.72719	.86281	.72913	54
7	.85816	.72137	.85933	.72333	.86050	.72528	.86167	.72722	.86282	.72916	53
+ 2′	9.85818	.72141	9.85935	.72336	9.86052	.72531	9.86169	.72725	9.86284	.72920	52
9	.85820	.72144	.85937	.72339	.86054	.72534	.86171	.72729	.86286	.72923	51
10	.85822	.72147	.85939	.72342	.86056	.72537	.86173	.72732	.86288	.72926	50
11	.85824	.72150	.85941	.72346	.86058	.72541	.86174	.72735	.86290	.72929	49
+ 3′	9.85826	.72154	9.85943	.72349	9.86060	.72544	9.86176	.72738	9.86292	.72932	48
13	.85828	.72157	.85945	.72352	.86062	.72547	.86178	.72742	.86294	.72936	47
14	.85830	.72160	.85947	.72355	.86064	.72550	.86180	.72745	.86296	.72939	46
15	.85832	.72163	.85949	.72359	.86066	.72554	.86182	.72748	.86298	.72942	45
+ 4′	9.85834	.72167	9.85951	.72362	9.86068	.72557	9.86184	.72751	9.86300	.72945	44
17	.85836	.72170	.85953	.72365	.86070	.72560	.86186	.72755	.86302	.72949	43
18	.85838	.72173	.85955	.72368	.86072	.72563	.86188	.72758	.86304	.72952	42
19	.85840	.72176	.85957	.72372	.86074	.72567	.86190	.72761	.86306	.72955	41
+ 5′	9.85841	.72180	9.85959	.72375	9.86076	.72570	9.86192	.72764	9.86307	.72958	40
21	.85843	.72183	.85961	.72378	.86078	.72573	.86194	.72768	.86309	.72962	39
22	.85845	.72186	.85963	.72381	.86080	.72576	.86196	.72771	.86311	.72965	38
23	.85847	.72189	.85965	.72385	.86081	.72580	.86198	.72774	.86313	.72968	37
+ 6′	9.85849	.72193	9.85967	.72388	9.86083	.72583	9.86200	.72777	9.86315	.72971	36
25	.85851	.72196	.85969	.72391	.86085	.72586	.86201	.72780	.86317	.72974	35
26	.85853	.72199	.85971	.72394	.86087	.72589	.86203	.72784	.86319	.72978	34
27	.85855	.72202	.85972	.72398	.86089	.72593	.86205	.72787	.86321	.72981	33
+ 7′	9.85857	.72206	9.85974	.72401	9.86091	.72596	9.86207	.72790	9.86323	.72984	32
29	.85859	.72209	.85976	.72404	.86093	.72599	.86209	.72793	.86325	.72987	31
30	.85861	.72212	.85978	.72407	.86095	.72602	.86211	.72797	.86327	.72991	30
31	.85863	.72215	.85980	.72411	.86097	.72606	.86213	.72800	.86329	.72994	29
+ 8′	9.85865	.72219	9.85982	.72414	9.86099	.72609	9.86215	.72803	9.86331	.72997	28
33	.85867	.72222	.85984	.72417	.86101	.72612	.86217	.72806	.86332	.73000	27
34	.85869	.72225	.85986	.72420	.86103	.72615	.86219	.72810	.86334	.73004	26
35	.85871	.72228	.85988	.72424	.86105	.72618	.86221	.72813	.86336	.73007	25
+ 9′	9.85873	.72232	9.85990	.72427	9.86107	.72622	9.86223	.72816	9.86338	.73010	24
37	.85875	.72235	.85992	.72430	.86109	.72625	.86225	.72819	.86340	.73013	23
38	.85877	.72238	.85994	.72433	.86111	.72628	.86227	.72823	.86342	.73016	22
39	.85879	.72242	.85996	.72437	.86112	.72631	.86229	.72826	.86344	.73020	21
+ 10′	9.85881	.72245	9.85998	.72440	9.86114	.72635	9.86230	.72829	9.86346	.73023	20
41	.85883	.72248	.86000	.72443	.86116	.72638	.86232	.72832	.86348	.73026	19
42	.85885	.72251	.86002	.72446	.86118	.72641	.86234	.72835	.86350	.73029	18
43	.85887	.72255	.86004	.72450	.86120	.72644	.86236	.72839	.86352	73033	17
+ 11′	9.85888	.72258	9.86006	.72453	9.86122	.72648	9.86238	.72842	9.86354	.73036	16
45	.85890	.72261	.86008	.72456	.86124	.72651	.86240	.72845	.86355	.73039	15
46	.85892	.72264	.86010	.72459	.86126	.72654	.86242	.72848	.86357	.73042	14
47	.85894	.72268	.86011	.72462	.86128	.72657	.86244	.72852	.86359	.73046	13
+ 12′	9.85896	.72271	9.86013	.72466	9.86130	.72661	9.86246	.72855	9.86361	.73049	12
49	.85898	.72274	.86015	.72469	.86132	.72664	.86248	.72858	.86363	.73052	11
50	.85900	.72277	.86017	.72472	.86134	.72667	.86250	.72861	.86365	.73055	10
51	.85902	.72281	.86019	72476	.86136	.72670	.86252	.72865	.86367	.73058	9
+ 13′	9.85904	.72284	9.86021	.72479	9.86138	.72674	9.86254	.72868	9.86369	.73062	8
53	.85906	.72287	.86023	.72482	.86140	.72677	.86256	.72871	.86371	.73065	7
54	.85908	.72290	.86025	.72485	.86142	.72680	.86257	.72874	.86373	.73068	6
55	.85910	.72294	.86027	.72489	.86143	.72683	.86259	.72878	.86375	.73071	5
+ 14′	9.85912	.72297	9.86029	.72492	9.86145	.72687	9.86261	.72881	9.86377	.73075	4
57	.85914	.72300	.86031	.72495	.86147	.72690	.86263	.72884	.86379	.73078	3
58	.85916	.72303	.86033	.72498	.86149	.72693	.86265	.72887	.86380	.73081	2
59	.85918	72307	.86035	.72502	.86151	.72696	.86267	.72890	.86382	.73084	1
+ 15′	9.85920	.72310	9.86037	.72505	9.86153	.72700	9.86269	.72894	9.86384	.73087	0
	$16^{h}\,14^{m}$		$16^{h}\,13^{m}$		$16^{h}\,12^{m}$		$16^{h}\,11^{m}$		$16^{h}\,10^{m}$		

TABLE 45.

Haversines.

s	$7^h 55^m$ 118° 45′		$7^h 56^m$ 119° 0′		$7^h 57^m$ 119° 15′		$7^h 58^m$ 119° 30′		$7^h 59^m$ 119° 45′		s
	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	
0	9.86952	.74049	9.87064	.74240	9.87175	.74431	9.87286	.74621	9.87396	.74811	60
1	.86954	.74052	.87066	.74244	.87177	.74434	.87288	.74624	.87398	.74814	59
2	.86956	.74056	.87068	.74247	.87179	.74437	.87290	.74628	.87400	.74817	58
3	.86958	.74059	.87070	.74250	.87181	.74441	.87292	.74631	.87402	.74820	57
+ 1′	9.86960	.74062	9.87072	.74253	9.87183	.74444	9.87294	.74634	9.87404	.74823	56
5	.86962	.74065	.87073	.74256	.87185	.74447	.87295	.74637	.87406	.74827	55
6	.86963	.74069	.87075	.74260	.87187	.74450	.87297	.74640	.87407	.74830	54
7	.86965	.74072	.87077	.74263	.87188	.74453	.87299	.74643	.87409	.74833	53
+ 2′	9.86967	.74075	9.87079	.74266	9.87190	.74456	9.87301	.74646	9.87411	.74836	52
9	.86989	.74078	.87081	.74269	.87192	.74460	.87303	.74650	.87413	.74839	51
10	.86971	.74081	.87083	.74272	.87194	.74463	.87305	.74653	.87415	.74842	50
11	.86973	.74084	.87085	.74275	.87196	.74466	.87306	.74656	.87417	.74846	49
+ 3′	9.86975	.74088	9.87086	.74279	9.87198	.74469	9.87308	.74659	9.87418	.74849	48
13	.86977	.74091	.87088	.74282	.87199	.74472	.87310	.74662	.87420	.74852	47
14	.86978	.74094	.87090	.74285	.87201	.74475	.87312	.74665	.87422	.74855	46
15	.86980	.74097	.87092	.74288	.87203	.74479	.87314	.74669	.87424	.74858	45
+ 4′	9.86982	.74100	9.87094	.74291	9.87205	.74482	9.87316	.74672	9.87426	.74861	44
17	.86984	.74104	.87096	.74294	.87207	.74485	.87318	.74675	.87428	.74864	43
18	.86986	.74107	.87098	.74298	.87209	.74488	.87319	.74678	.87429	.74868	42
19	.86988	.74110	.87100	.74301	.87211	.74491	.87321	.74681	.87431	74871	41
+ 5′	9.86990	.74113	9.87101	.74304	9.87212	.74494	9.87323	.74684	9.87433	.74874	40
21	.86991	.74116	.87103	.74307	.87214	.74498	.87325	.74688	.87435	.74877	39
22	.86993	.74120	.87105	.74310	.87216	.74501	.87327	.74691	.87437	.74880	38
23	.86995	.74123	.87107	.74314	.87218	.74504	.87329	.74694	.87439	.74883	37
+ 6′	9.86997	.74126	9.87109	.74317	9.87220	.74507	9.87330	.74697	9.87440	.74887	36
25	.86999	.74129	.87111	.74320	.87222	.74510	.87332	.74700	.87442	.74890	35
26	.87001	.74132	.87112	.74323	.87224	.74514	.87334	.74703	.87444	.74893	34
27	.87003	.74135	.87114	.74326	.87225	.74517	.87336	.74707	.87446	.74896	33
+ 7′	9.87004	.74139	9.87116	.74329	9.87227	.74520	9.87338	.74710	9.87448	.74899	32
29	.87006	.74142	.87118	.74333	.87229	.74523	.87340	.74713	.87450	.74902	31
30	.87008	.74145	.87120	.74336	.87231	.74526	.87341	.74716	.87451	.74905	30
31	.87010	.74148	.87122	.74339	.87233	.74529	.87343	.74719	.87453	.74908	29
+ 8′	9.87012	.74151	9.87124	.74342	9.87235	.74533	9.87345	.74722	9.87455	.74912	28
33	.87014	.74155	.87125	.74345	.87236	.74536	.87347	.74726	.87457	.74915	27
34	.87016	.74158	.87127	.74349	.87238	.74539	.87349	.74729	.87459	.74918	26
35	.87018	.74161	.87129	.74352	.87240	.74542	.87351	.74732	.87460	.74921	25
+ 9′	9.87019	.74164	9.87131	.74355	9.87242	.74545	9.87352	.74735	9.87462	.74924	24
37	.87021	.74167	.87133	.74358	.87244	.74548	.87354	.74738	.87464	.74928	23
38	.87023	.74170	.87135	.74361	.87246	.74552	.87356	.74741	.87466	.74931	22
39	.87025	.74174	.87137	.74364	.87248	.74555	.87358	.74744	.87468	.74934	21
+ 10′	9.87027	.74177	9.87138	.74368	9.87249	.74558	9.87360	.74748	9.87470	.74937	20
41	.87029	.74180	.87140	.74371	.87251	.74561	.87362	.74751	.87471	.74940	19
42	.87031	.74183	.87142	.74374	.87253	.74564	.87363	.74754	.87473	.74943	18
43	.87032	.74186	.87144	.74377	.87255	.74567	.87365	.74757	.87475	.74946	17
+ 11′	9.87034	.74190	9.87146	.74380	9.87257	.74571	9.87367	.74760	9.87477	.74950	16
45	.87036	.74193	.87148	.74383	.87259	.74574	.87369	.74763	.87479	.74953	15
46	.87038	.74196	.87149	.74387	.87260	.74577	.87371	.74767	.87481	.74956	14
47	.87040	.74199	.87151	.74390	.87262	.74580	.87373	.74770	.87482	.74959	13
+ 12′	9.87042	.74202	9.87153	.74393	9.87264	.74583	9.87374	.74773	9.87484	.74962	12
49	.87044	.74205	.87155	.74396	.87266	.74586	.87376	.74776	.87486	.74965	11
50	.87045	.74209	.87157	.74399	.87268	.74590	.87378	.74779	.87488	.74969	10
51	.87047	.74212	.87159	.74402	.87270	.74593	.87380	.74782	.87490	.74972	9
+ 13′	9.87049	.74215	9.87161	.74406	9.87271	.74596	9.87382	.74786	9.87492	.74975	8
53	.87051	.74218	.87162	.74409	.87273	.74599	.87384	.74789	.87493	.74978	7
54	.87053	.74221	.87164	.74412	.87275	.74602	.87385	.74792	.87495	.74981	6
55	.87055	.74225	.87166	.74415	.87277	.74605	.87387	.74795	.87497	.74984	5
+ 14′	9.87057	.74228	9.87168	.74418	9.87279	.74609	9.87389	.74798	9.87499	.74987	4
57	.87059	.74231	.87170	.74422	.87281	.74612	.87391	.74801	.87501	.74991	3
58	.87060	.74234	.87172	.74425	.87283	.74615	.87393	.74805	.87502	.74994	2
59	.87062	.74237	.87174	.74428	.87284	.74618	.87395	.74808	.87504	.74997	1
+ 15′	9.87064	.74240	9.87175	.74431	9.87286	.74621	9.87396	.74811	9.87506	.75000	0
	$16^h 4^m$		$16^h 3^m$		$16^h 2^m$		$16^h 1^m$		$16^h 0^m$		

TABLE 45.

Haversines.

s ′	8h 10m 122° 30′		8h 12m 123° 0′		8h 14m 123° 30′		8h 16m 124° 0′		8h 18m 124° 30′		s
	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	
0 0	9.88573	0.76865	9.88780	0.77232	9.88984	0.77597	9.89187	0.77960	9.89387	0.78320	60
2	.88576	.76871	.88783	.77238	.88988	.77603	.89190	.77966	.89391	.78326	58
4+ 1	.88580	.76877	.88787	.77244	.88991	.77609	.89194	.77972	.89394	.78332	56
6	.88583	.76883	.88790	.77250	.88995	.77615	.89197	.77978	.89397	.78338	54
8+ 2	9.88587	0.76890	9.88793	0.77256	9.88998	0.77621	9.89200	0.77984	9.89400	0.78344	52
10	.88590	.76896	.88797	.77262	.89001	.77627	.89204	.77990	.89404	.78350	50
12+ 3	.88594	.76902	.88800	.77269	.89005	.77633	.89207	.77996	.89407	.78356	48
14	.88597	.76908	.88804	.77275	.89008	.77639	.89210	.78002	.89411	.78362	46
16+ 4	9.88600	0.76914	9.88807	0.77281	9.89012	0.77645	9.89214	0.78008	9.89414	0.78368	44
18	.88604	.76920	.88811	.77287	.89015	.77651	.89217	.78014	.89417	.78374	42
20+ 5	.88607	.76926	.88814	.77293	.89018	.77657	.89221	.78020	.89421	.78380	40
22	.88611	.76932	.88817	.77299	.89022	.77664	.89224	.78026	.89424	.78386	38
24+ 6	9.88614	.076939	9.88821	0.77305	9.89025	0.77670	9.89227	0.78032	9.89427	0.78392	36
26	.88618	.76945	.88824	.77311	.89028	.77676	.89231	.78038	.89431	.78398	34
28+ 7	.88621	.76951	.88828	.77317	.89032	.77682	.89234	.78044	.89434	.78404	32
30	.88625	.76957	.88831	.77323	.89035	.77688	.89237	.78050	.89437	.78410	30
32+ 8	9.88628	0.76963	9.88835	0.77329	9.89039	0.77694	9.89241	0.78056	9.89441	0.78416	28
34	.88632	.76969	.88838	.77336	.89042	.77700	.89244	.78062	.89444	.78422	26
36+ 9	.88635	.76975	.88841	.77342	.89045	.77706	.89247	.78068	.89447	.78428	24
38	.88639	.76981	.88845	.77348	.89049	.77712	.89251	.78074	.89450	.78434	22
40+10	9.88642	0.76988	9.88848	0.77354	9.89052	0.77718	9.89254	0.78080	9.89454	0.78440	20
42	.88645	.76994	.88852	.77360	.89056	.77724	.89257	.78086	.89457	.78446	18
44+11	.88649	.77000	.88855	.77366	.89059	.77730	.89261	.78092	.89460	.78452	16
46	.88652	.77006	.88858	.77372	.89062	.77736	.89264	.78098	.89464	.78458	14
48+12	9.88656	0.77012	9.88862	0.77378	9.89066	0.77742	9.89267	0.78104	9.89467	0.78464	12
50	.88659	.77018	.88865	.77384	.89069	.77748	.89271	.78110	.89470	.78470	10
52+13	.88663	.77024	.88869	.77390	.89072	.77754	.89274	.78116	.89474	.78476	8
54	.88666	.77030	.88872	.77396	.89076	.77760	.89277	.78122	.89477	.78482	6
56+14	9.88670	0.77036	9.88876	0.77403	9.89079	0.77766	9.89281	0.78128	9.89480	0.78488	4
58	9.88673	0.77042	9.88879	0.77409	9.89083	0.77772	9.89284	0.78134	9.89484	0.78494	2
	15h 49m		15h 47m		15h 45m		15h 43m		15h 41m		

s ′	8h 11m 122° 30′		8h 13m 123° 0′		8h 15m 123° 30′		8h 17m 124° 0′		8h 19m 124° 30′		s
0+15	9.88677	0.77049	9.88882	0.77415	9.89086	0.77779	9.89287	0.78140	9.89487	0.78500	60
2	.88680	.77055	.88886	.77421	.89089	.77785	.89291	.78146	.89490	.78506	58
4+16	.88683	.77061	.88889	.77427	.89093	.77791	.89294	.78152	.89493	.78512	56
6	.88687	.77067	.88893	.77433	.89096	.77797	.89298	.78158	.89497	.78518	54
8+17	9.88690	0.77073	9.88896	0.77439	9.89099	0.77803	9.89301	0.78164	9.89500	0.78524	52
10	.88694	.77079	.88899	.77445	.89102	.77809	.89304	.78170	.89503	.78530	50
12+18	.88697	.77085	.88903	.77451	.89106	.77815	.89308	.78176	.89507	.78536	48
14	.88701	.77092	.88906	.77457	.89110	.77821	.89311	.78182	.89510	.78542	46
16+19	9.88704	0.77098	9.88910	0.77463	9.89113	0.77827	9.89314	0.78188	9.89513	0.78548	44
18	.88708	.77104	.88913	.77469	.89116	.77833	.89318	.78194	.89517	.78554	42
20+20	.88711	.77110	.88916	.77475	.89120	.77839	.89321	.78200	.89520	.78560	40
22	.88714	.77116	.88920	.77482	.89123	.77845	.89324	.78206	.89523	.78566	38
24+21	9.88718	0.77122	9.88923	0.77488	9.89126	0.77851	9.89328	0.78212	9.89527	0.78572	36
26	.88721	.77128	.88927	.77494	.89130	.77857	.89331	.78218	.89530	.78577	34
28+22	.88725	.77134	.88930	.77500	.89133	.77863	.89334	.78224	.89533	.78583	32
30	.88728	.77140	.88933	.77506	.89137	.77869	.89338	.78230	.89536	.78589	30
32+23	9.88732	0.77147	9.88937	0.77512	9.89140	0.77875	9.89341	0.78236	9.89540	0.78595	28
34	.88735	.77153	.88940	.77518	.89143	.77881	.89344	.78242	.89543	.78601	26
36+24	.88739	.77159	.88944	.77524	.89147	.77887	.89348	.78248	.89546	.78607	24
38	.88742	.77165	.88947	.77530	.89150	.77893	.89351	.78254	.89550	.78613	22
40+25	9.88745	0.77171	9.88950	0.77536	9.89153	0.77899	9.89354	0.78260	9.89553	0.78619	20
42	.88749	.77177	.88954	.77542	.89157	.77905	.89358	.78266	.89556	.78625	18
44+26	.88752	.77183	.88957	.77548	.89160	.77911	.89361	.78272	.89559	.78631	16
46	.88756	.77189	.88961	.77554	.89163	.77917	.89364	.78278	.89563	.78637	14
48+27	9.88759	0.77195	9.88964	0.77560	9.89167	0.77923	9.89368	0.78284	9.89566	0.78643	12
50	.88763	.77201	.88967	.77567	.89170	.77929	.89371	.78290	.89569	.78649	10
52+28	.88766	.77208	.88971	.77573	.89174	.77936	.89374	.78296	.89573	.78655	8
54	.88769	.77214	.88974	.77579	.89177	.77942	.89378	.78302	.89576	.78661	6
56+29	9.88773	0.77220	9.88978	0.77585	9.89180	0.77948	9.89381	0.78308	9.89579	0.78667	4
58	.88776	.77226	.88981	.77591	.89184	.77954	.89384	.78314	.89583	.78673	2
60+30	9.88780	0.77232	9.88984	0.77597	9.89187	0.77960	9.89387	0.78320	9.89586	0.78679	0
	15h 48m		15h 46m		15h 44m		15h 42m		15h 40m		

TABLE 45.

Haversines.

s ′	$8^h\,30^m$ 127° 30′		$8^h\,32^m$ 128° 0′		$8^h\,34^m$ 128° 30′		$8^h\,36^m$ 129° 0′		$8^h\,38^m$ 129° 30′		s
	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	
0 0	9.90546	0.80438	9.90732	0.80783	9.90916	0.81126	9.91098	0.81466	9.91277	0.81804	60
2	.90549	.80444	.90735	.80789	.90919	.81131	.91101	.81472	.91280	.81810	58
4+ 1	.90552	.80450	.90738	.80795	.90922	.81137	.91104	.81477	.91283	.81815	56
6	.90556	.80455	.90741	.80800	.90925	.81143	.91107	.81483	.91286	.81821	54
8+ 2	9.90559	0.80461	9.90744	0.80806	9.90928	0.81148	9.91110	0.81489	9.91289	0.81826	52
10	.90562	.80467	.90747	.80812	.90931	.81154	.91113	.81494	.91292	.81832	50
12+ 3	.90565	.80473	.90751	.80817	.90934	.81160	.91116	.81500	.91295	.81838	48
14	.90568	.80478	.90754	.80823	.90937	.81165	.91119	.81506	.91298	.81843	46
16+ 4	9.90571	0.80484	9.90757	0.80829	9.90940	0.81171	9.91122	0.81511	9.91301	0.81849	44
18	.90574	.80490	.90760	.80835	.90943	.81177	.91125	.81517	.91304	.81854	42
20+ 5	.90577	.80496	.90763	.80840	.90946	.81183	.91128	.81523	.91307	.81860	40
22	.90580	.80502	.90766	.80846	.90949	.81188	.91131	.81528	.91310	.81866	38
24+ 6	9.90584	0.80507	9.90769	0.80852	9.90952	0.81194	9.91134	0.81534	9.91313	0.81871	36
26	.90587	.80513	.90772	.80858	.90955	.81200	.91137	.81539	.91316	.81877	34
28+ 7	.90590	.80519	.90775	.80863	.90958	.81205	.91140	.81545	.91319	.81882	32
30	.90593	.80525	.90778	.80869	.90962	.81211	.91143	.81551	.91322	.81888	30
32+ 8	9.90596	0.80530	9.90781	0.80875	9.90965	0.81217	9.91146	0.81556	9.91325	0.81894	28
34	.90599	.80536	.90784	.80880	.90968	.81222	.91149	.81562	.91328	.81899	26
36+ 9	.90602	.80542	.90787	.80886	.90971	.81228	.91152	.81568	.91331	.81905	24
38	.90605	.80548	.90790	.80892	.90974	.81234	.91155	.81573	.91334	.81910	22
40+10	9.90608	0.80553	9.90794	0.80898	9.90977	0.81239	9.91158	0.81579	9.91337	0.81916	20
42	.90611	.80559	.90797	.80903	.90980	.81245	.91161	.81585	.91340	.81922	18
44+11	.90615	.80565	.90800	.80909	.90983	.81251	.91164	.81590	.91343	.81927	16
46	.90618	.80571	.90803	.80915	.90986	.81256	.91167	.81596	.91346	.81933	14
48+12	9.90621	0.80576	9.90806	0.80920	9.90989	0.81262	9.91170	0.81601	9.91349	0.81938	12
50	.90624	.80582	.90809	.80926	.90992	.81268	.91173	.81607	.91352	.81944	10
52+13	.90627	.80588	.90812	.80932	.90995	.81273	.91176	.81613	.91355	.81950	8
54	.90630	.80594	.90815	.80938	.90998	.81279	.91179	.81618	.91358	.81955	6
56+14	9.90633	0.80599	9.90818	0.80943	9.91001	0.81285	9.91182	0.81624	9.91361	0.81961	4
58	9.90636	0.80605	9.90821	0.80949	9.91004	0.81291	9.91185	0.81630	9.91364	0.81966	2
	$15^h\,29^m$		$15^h\,27^m$		$15^h\,25^m$		$15^h\,23^m$		$15^h\,21^m$		

s ′	$8^h\,31^m$ 127° 30′		$8^h\,33^m$ 128° 0′		$8^h\,35^m$ 128° 30′		$8^h\,37^m$ 129° 0′		$8^h\,39^m$ 129° 30′		s
0+15	9.90639	0.80611	9.90824	0.80955	9.91007	0.81296	9.91188	0.81635	9.91367	0.81972	60
2	.90642	.80617	.90827	.80960	.91010	.81302	.91191	.81641	.91369	.81978	58
4+16	.90646	.80622	.90830	.80966	.91013	.81308	.91194	.81647	.91372	.81983	56
6	.90646	.80628	.90833	.80972	.91016	.81313	.91197	.81652	.91375	.81989	54
8+17	9.90652	0.80634	9.90836	0.80978	9.91019	0.81319	9.91200	0.81658	9.91378	0.81994	52
10	.90655	.80640	.90840	.80983	.91022	.81325	.91203	.81663	.91381	.82000	50
12+18	.90658	.80645	.90843	.80989	.91025	.81330	.91206	.81669	.91384	.82005	48
14	.90661	.80651	.90846	.80995	.91028	.81336	.91209	.81675	.91387	.82011	46
16+19	9.90664	0.80657	9.90849	0.81000	9.91031	0.81342	9.91212	0.81680	9.91390.	0.82017	44
18	.90667	.80663	.90852	.81006	.91034	.81347	.91215	.81686	.91393	.82022	42
20+20	.90670	.80668	.90855	.81012	.91037	.81353	.91218	.81692	.91396	.82028	40
22	.90673	.80674	.90858	.81017	.91040	.81359	.91221	.81697	.91399	.82033	38
24+21	9.90676	0.80680	9.90861	0.81023	9.91043	0.81364	9.91224	0.81703	9.91402	0.82039	36
26	.90680	.80686	.90864	.81029	.91046	.81370	.91227	.81708	.91405	.82045	34
28+22	.90683	.80691	.90867	.81035	.91049	.81376	.91230	.81714	.91408	.82050	32
30	.90686	.80697	.90870	.81040	.91052	.81381	.91233	.81720	.91411	.82056	30
32+23	9.90689	0.80703	9.90873	0.81046	9.91055	0.81387	9.91236	0.81725	9.91414	0.82061	28
34	.90692	.80709	.90876	.81052	.91058	.81392	.91239	.81731	.91417	.82067	26
36+24	.90695	.80714	.90879	.81057	.91061	.81398	.91242	.81737	.91420	.82072	24
38	.90698	.80720	.90882	.81063	.91064	.81404	.91245	.81742	.91423	.82078	22
40+25	9.90701	0.80726	9.90885	0.81068	9.91067	0.81409	9.91248	0.81748	9.91426	0.82084	20
42	.90704	.80731	.90888	.81074	.91071	.81415	.91251	.81753	.91429	.82089	18
44+26	.90707	.80737	.90892	.81080	.91074	.81421	.91254	.81759	.91432	.82095	16
46	.90710	.80743	.90895	.81086	.91077	.81426	.91257	.81765	.91435	.82100	14
48+27	9.90714	0.80749	9.90898	0.81092	9.91080	0.81432	9.91260	0.81770	9.91437	0.82106	12
50	.90717	.80754	.90901	.81097	.91083	.81438	.91263	.81776	.91440	.82112	10
52+28	.90720	.80760	.90904	.81103	.91086	.81443	.91265	.81781	.91443	.82117	8
54	.90723	.80766	.90907	.81109	.91089	.81449	.91268	.81787	.91446	.82123	6
56+29	9.90726	0.80772	9.90910	0.81114	9.91092	0.81455	9.91271	0.81793	9.91449	0.82128	4
58	.90729	.80777	.90913	.81120	.91095	.81460	.91274	.81798	.91452	.82134	2
60+30	9.90732	0.80783	9.90916	0.81126	9.91098	0.81466	9.91277	0.81804	9.91455	0.82139	0
	$15^h\,28^m$		$15^h\,26^m$		$15^h\,24^m$		$15^h\,22^m$		$15^h\,20^m$		

TABLE 45.

Haversines.

		$8^h\,40^m$ 130° 0′		$8^h\,42^m$ 130° 30′		$8^h\,44^m$ 131° 0′		$8^h\,46^m$ 131° 30′		$8^h\,48^m$ 132° 0′		
s	′	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	s
0	0	9.91455	0.82139	9.91631	0.82472	9.91805	0.82803	9.91976	0.83131	9.92146	0.83457	60
2		.91458	.82145	.91634	.82478	.91807	.82808	.91979	.83136	.92149	.83462	58
4	+ 1	.91461	.82151	.91637	.82483	.91810	.82814	.91982	.83142	.92152	.83467	56
6		.91464	.82156	.91640	.82489	.91813	.82819	.91985	.83147	.92154	.83473	54
8	+ 2	9.91467	0.82162	9.91643	0.82495	9.91816	0.82825	9.91988	0.83153	9.92157	0.83478	52
10		.91470	.82167	.91645	.82500	.91819	.82830	.91991	.83158	.92160	.83484	50
12	+ 4	.91473	.82173	.91648	.82506	.91822	.82836	.91993	.83164	.92163	.83489	48
14		.91476	.82178	.91651	.82511	.91825	.82841	.91996	.83169	.92166	.83494	46
16	+ 4	9.91479	0.82184	9.91654	0.82517	9.91828	0.82847	9.91999	0.83175	9.92169	0.83500	44
18		.91482	.82189	.91657	.82522	.91830	.82852	.92002	.83180	.92171	.83505	42
20	+ 5	.91485	.82195	.91660	.82528	.91833	.82858	.92005	.83185	.92174	.83511	40
22		.91488	.82200	.91663	.82533	.91836	.82863	.92008	.83191	.92177	.83516	38
24	+ 6	9.91490	0.82206	9.91666	0.82539	9.91839	0.82869	9.92010	0.83196	9.92180	0.83521	36
26		.91493	.82212	.91669	.82544	.91842	.82874	.92013	.83202	.92183	.83527	34
28	+ 7	.91496	.82217	.91672	.82550	.91845	.82880	.92016	.83207	.92185	.83532	32
30		.91499	.82223	.91674	.82555	.91848	.82885	.92019	.83213	.92188	.83538	30
32	+ 8	9.91502	0.82228	9.91677	0.82561	9.91851	0.82891	9.92022	0.83218	9.92191	0.83543	28
34		.91505	.82234	.91680	.82566	.91853	.82896	.92025	.83224	.92194	.83548	26
36	+ 9	.91508	.82240	.91683	.82572	.91856	.82902	.92027	.83229	.92197	.83554	24
38		.91511	.82245	.91686	.82577	.91859	.82907	.92030	.83234	.92199	.83559	22
40	+10	9.91514	0.82251	9.91689	0.82583	9.91862	0.82913	9.92033	0.83240	9.92202	0.83564	20
42		.91517	.82256	.91692	.82588	.91865	.82918	.92036	.83245	.92205	.83570	18
44	+11	.91520	.82262	.91695	.82594	.91868	.82924	.92039	.83251	.92208	.83575	16
46		.91523	.82267	.91698	.82599	.91871	.82929	.92042	.83256	.92211	.83581	14
48	+12	9.91526	0.82273	9.91701	0.82605	9.91874	0.82934	9.92044	0.83262	9.92213	0.83586	12
50		.91529	.82278	.91703	.82610	.91876	.82940	.92047	.83267	.92216	.83591	10
52	+13	.91532	.82284	.91706	.82616	.91879	.82945	.92050	.83272	.92219	.83597	8
54		.91534	.82290	.91709	.82621	.91882	.82951	.92053	.83278	.92222	.83602	6
56	+14	9.91537	0.82295	9.91712	0.82627	9.91885	0.82956	9.92056	0.83283	9.92225	0.83608	4
58		9.91540	0.82301	9.91715	0.82632	9.91888	0.82962	9.92059	0.83289	9.92227	0.83613	2
		$15^h\,19^m$		$15^h\,17^m$		$15^h\,15^m$		$15^h\,13^m$		$15^h\,11^m$		

		$8^h\,41^m$ 130° 0′		$8^h\,43^m$ 130° 30′		$8^h\,45^m$ 131° 0′		$8^h\,47^m$ 131° 30:		$8^h\,49^m$ 132° 0′		
s	′											s
0	+15	9.91543	0.82306	9.91718	0.82638	9.91891	0.82967	9.92061	0.83294	9.92230	0.83618	60
2		.91546	.82312	.91721	.82644	.91894	.82973	.92064	.83300	.92233	.83624	58
4	+16	.91549	.82317	.91724	.82649	.91896	.82978	.92067	.83305	.92236	.83629	56
6		.91552	.82323	.91727	.82655	.91899	.82984	.92070	.83310	.92239	.83635	54
8	+17	9.91555	0.82328	9.91730	0.82660	9.91902	0.82989	9.92073	0.83316	9.92241	0.83640	52
10		.91558	.82334	.91732	.82666	.91905	.82995	.92076	.83321	.92244	.83645	50
12	+18	.91561	.82339	.91735	.82671	.91908	.83000	.92078	.83327	.92247	.83651	48
14		.91564	.82345	.91738	.82677	.91911	.83006	.92081	.83332	.92250	.83656	46
16	+19	9.91567	0.82351	9.91741	0.82682	9.91914	0.83011	9.92084	0.83337	9.92253	0.83661	44
18		.91570	.82356	.91744	.82688	.91916	.83016	.92087	.83343	.92255	.83667	42
20	+20	.91573	.82362	.91747	.82693	.91919	.83022	.92090	.83348	.92258	.83672	40
22		.91575	.82367	.91750	.82699	.91922	.83027	.92093	.83354	.92261	.83678	38
24	+21	9.91578	0.82373	9.91753	0.82704	9.91925	0.83033	9.92095	0.83359	9.92264	0.83683	36
26		.91581	.82378	.91756	.82710	.91928	.83038	.92098	.83365	.92266	.83688	34
28	+22	.91584	.82384	.91758	.82715	.91931	.83044	.92101	.83370	.92269	.83694	32
30		.91587	.82389	.91761	.82721	.91934	.83049	.92104	.83375	.92272	.83699	30
32	+23	9.91590	0.82395	9.91764	0.82726	9.91936	0.83055	9.92107	0.83381	9.92275	0.83704	28
34		.91593	.82400	.91767	.82732	.91939	.83060	.92109	.83386	.92278	.83710	26
36	+24	.91596	.82406	.91770	.82737	.91942	.83066	.92112	.83392	.92280	.83715	24
38		.91599	.82412	.91773	.82743	.91945	.83071	.92115	.83397	.92283	.83720	22
40	+25	9.91602	0.82417	9.91776	0.82748	9.91948	0.83077	9.92118	0.83402	9.92286	0.83726	20
42		.91605	.82423	.91779	.82754	.91951	.83082	.92121	.83408	.92289	.83731	18
44	+26	.91608	.82428	.91782	.82759	.91954	.83087	.92124	.83413	.92292	.83737	16
46		.91610	.82434	.91784	.82765	.91956	.83093	.92126	.83419	.92294	.83742	14
48	+27	9.91613	0.82439	9.91787	0.82770	9.91959	0.83098	9.92129	0.83424	9.92297	0.83747	12
50		.91616	.82445	.91790	.82776	.91962	.83104	.92132	.83430	.92300	.83753	10
52	+28	.91619	.82450	.91793	.82781	.91965	.83109	.92135	.83435	.92303	.83758	8
54		.91622	.82456	.91796	.82786	.91968	.83115	.92138	.83440	.92305	.83763	6
56	+29	9.91625	0.82461	9.91799	0.82792	9.91971	0.83120	9.92140	0.83446	9.92308	0.83769	4
58		.91628	.82467	.91802	.82797	.91973	.83126	.92143	.83451	.92311	.83774	2
60	+30	9.91631	0.82472	9.91805	0.82803	9.91976	0.83131	9.92146	0.83457	9.92314	0.83780	0
		$15^h\,18^m$		$15^h\,16^m$		$15^h\,14^m$		$15^h\,12^m$		$15^h\,10^m$		

TABLE 45.

Haversines.

s ′	$8^h\,50^m$ 132° 30′		$8^h\,52^m$ 133° 0′		$8^h\,54^m$ 133° 30′		$8^h\,56^m$ 134° 0′		$8^h\,58^m$ 134° 30′		s
	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	
0 0	9.92314	0.83780	9.92480	0.84100	9.92643	0.84418	9.92805	0.84733	9.92965	0.85045	60
2	.92317	.83785	.92482	.84105	.92646	.84423	.92808	.84738	.92968	.85051	58
4+ 1	.92319	.83790	.92485	.84111	.92649	.84428	.92811	.84743	.92970	.85056	56
6	.92322	.83796	.92488	.84116	.92652	.84434	.92813	.84749	.92973	.85061	54
8+ 2	9.92325	0.83801	9.92491	0.84121	9.92654	0.84439	9.92816	0.84754	9.92975	0.85066	52
10	.92328	.83806	.92493	.84127	.92657	.84444	.92819	.84759	.92978	.85071	50
12+ 3	.92330	.83812	.92496	.84132	.92660	.84449	.92821	.84764	.92981	.85077	48
14	.92333	.83817	.92499	.84137	.92662	.84455	.92824	.84770	.92984	.85082	46
16+ 4	9.92336	0.83822	9.92502	0.84142	9 92665	0.84460	9.92827	0.84775	9.92986	0.85087	44
18	.92339	.83828	.92504	.84148	.92668	.84465	.92829	.84780	.92989	.85092	42
20+ 5	.92342	.83833	.92507	.84153	.92670	.84470	.92832	.84785	.92992	.85097	40
22	.92344	.83838	.92510	.84158	.92673	.84476	.92835	.84790	.92994	.85102	38
24+ 6	9.92347	0.83844	9.92512	0.84164	9.92676	0.84481	9.92837	0.84796	9.92997	0.85108	36
26	.92350	.83849	.92515	.84169	.92679	.84486	.92840	.84801	.93001	.85113	34
28+ 7	.92353	.83855	.92518	.84174	.92681	.84492	.92843	.84806	.93002	.85118	32
30	.92355	.83860	.92521	.84180	.92684	.84497	.92845	.84811	.93005	.85123	30
32+ 8	9.92358	0.83865	9.92523	0.84185	9.92687	0.84502	9.92848	0.84817	9.93007	0.85128	28
34	.92361	.83871	.92526	.84190	.92689	.84507	.92851	.84822	.93010	.85134	26
36+ 9	.92364	.83876	.92529	.84196	.92692	.84513	.92853	.84827	.93013	.85139	24
38	.92366	.83881	.92532	.84201	.92695	.84518	.92856	.84832	.93015	.85144	22
40+10	9.92369	0.83887	9.92534	0.84206	9.92698	0.84523	9.92859	0.84837	9.93018	0.85149	20
42	.92372	.83892	.92537	.84211	.92700	.84528	.92861	.84843	.93021	.85154	18
44+11	.92375	.83897	.92540	.84217	.92703	.84534	.92864	.84848	.93023	.85159	16
46	.92378	.83903	.92543	.84222	.92706	.84539	.92867	.84853	.93026	.85165	14
48+12	9.92380	0.83908	9.92545	0.84227	9.92708	0.84544	9.92869	0.84858	9.93029	0.85170	12
50	.92383	.83913	.92548	.84233	.92711	.84549	.92872	.84863	.93031	.85175	10
52+13	.92386	.83919	.92551	.84238	.92714	.84555	.92875	.84869	.93034	.85180	8
54	.92389	.83924	.92554	.84243	.92716	.84560	.92877	.84874	.93036	.85185	6
56+14	9.92391	0.83929	9.92556	0.84249	9.92719	0.84565	9.92880	0.84879	9.93039	0.85190	4
58	9.92394	0.83935	9.92559	0.84254	9.92722	0.84570	9.92883	0.84884	9.93042	0.85196	2
	$15^h\,9^m$		$15^h\,7^m$		$15^h\,5^m$		$15^h\,3^m$		$15^h\,1^m$		

s ′	$8^h\,51^m$ 132° 30′		$8^h\,53^m$ 133° 0′		$8^h\,55^m$ 133° 30′		$8^h\,57^m$ 134° 0′		$8^h\,59^m$ 134° 30′		s
0+15	9.92397	0.83940	9.92562	0.84259	9.92725	0.84576	9.92885	0.84890	9.93044	0.85201	60
2	.92400	.83945	.92564	.84264	.92727	.84581	.92888	.84895	.93047	.85206	58
4+16	.92402	.83951	.92567	.84270	.92730	.84586	.92891	.84900	.93050	.85211	56
6	.92405	.83956	.92570	.84275	.92733	.84591	.92893	.84905	.93052	.85216	54
8+17	9.92408	0.83961	9.92573	0.84280	9.92735	0.84597	9.92896	0.84910	9.93055	0.85221	52
10	.92411	.83967	.92575	.84286	.92738	.84602	.92899	.84916	.93057	.85227	50
12+18	.92413	.83972	.92578	.84291	.92741	.84607	.92901	.84921	.93060	.85232	48
14	.92416	.83977	.92581	.84296	.92743	.84612	.92904	.84926	.93063	.85237	46
16+19	9.92419	0.83983	9.92584	0.84302	9.92746	0.84618	9.92907	0.84931	9.93065	0.85242	44
18	.92422	.83988	.92586	.84307	.92749	.84623	.92909	.84936	.93068	.85247	42
20+20	.92425	.83993	.92589	.84312	.92751	.84628	.92912	.84942	.93071	.85252	40
22	.92427	.83999	.92592	.84317	.92754	.84633	.92915	.84947	.93073	.85258	38
24+21	9.92430	0.84004	9.92594	0.84323	9.92757	0.84639	9.92917	0.84952	9.93076	0.85263	36
26	.92433	.84009	.92597	.84328	.92760	.84644	.92920	.84957	.93079	.85268	34
28+22	.92436	.84015	.92600	.84333	.92762	.84649	.92923	.84962	.93081	.85273	32
30	.92438	.84020	.92603	.84339	.92765	.84654	.92925	.84968	.93084	.85278	30
32+23	9.92441	0.84025	9.92605	0.84344	9.92768	0.84660	9.92928	0.84973	9.93086	0.85283	28
34	.92444	.84031	.92608	.84349	.92770	.84665	.92931	.84978	.93089	.85288	26
36+24	.92447	.84036	.92611	.84354	.92773	.84670	.92933	.84983	.93092	.85294	24
38	.92449	.84041	.92613	.84360	.92776	.84675	.92936	.84988	.93094	.85299	22
40+25	9.92452	0.84047	9.92616	0.84365	9.92778	0.84681	9.92939	0.84994	9.93097	0.85304	20
42	.92455	.84052	.92619	.84370	.92781	.84686	.92941	.84999	.93100	.85309	18
44+26	.92458	.84057	.92622	.84376	.92784	.84691	.92944	.85004	.93102	.85314	16
46	.92460	.84063	.92624	.84381	.92786	.84696	.92947	.85009	.93105	.85319	14
48+27	9.92463	0.84068	9.92627	0.84386	9.92789	0.84702	9.92949	0.85014	9.93107	0.85324	12
50	.92466	.84073	.92630	.84391	.92792	.84707	.92952	.85020	.93110	.85330	10
52+28	.92469	.84079	.92633	.84397	.92794	.84712	.92955	.85025	.93113	.85335	8
54	.92471	.84084	.92635	.84402	.92797	.84717	.92957	.85030	.93115	.85340	6
56+29	9.92474	0.84089	9.92638	0.84407	9.92800	0.84722	9.92960	0.85035	9.93118	0.85345	4
58	.92477	.84095	.92641	.84412	.92802	.84728	.92962	.85040	.93120	.85350	2
60+30	9.92480	0.84100	9.92643	0.84418	9.92805	0.84733	9.92965	0.85045	9.93123	0.85355	0
	$15^h\,8^m$		$15^h\,6^m$		$15^h\,4^m$		$15^h\,2^m$		$15^h\,0^m$		

TABLE 45.

Haversines.

s	′	$9^h 20^m$	140°	$9^h 24^m$	141°	$9^h 28^m$	142°	$9^h 32^m$	143°	$9^h 36^m$	144°	s
		Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	
0	0	9.94597	0.88302	9.94869	0.88857	9.95134	0.89401	9.95391	0.89932	9.95641	0.90451	60
4	1	.94602	.88312	.94874	.88866	.95138	.89409	.95396	.89941	.95645	.90459	56
8	2	.94606	.88321	.94878	.88876	.95143	.89418	.95400	.89949	.95649	.90468	52
12	3	.94611	.88330	.94883	.88885	.95147	.89427	.95404	.89958	.95654	.90476	48
16	4	9.94616	0.88340	9.94887	0.88894	9.95151	0.89436	9.95408	0.89967	9.95658	0.90485	44
20	5	.94620	.88349	.94892	.88903	.95156	.89445	.95412	.89976	.95662	.90494	40
24	6	.94625	.88358	.94896	.88912	.95160	.89454	.95417	.89984	.95666	.90502	36
28	7	.94629	.88368	.94901	.88921	.95164	.89463	.95421	.89993	.95670	.90511	32
32	8	9.94634	0.88377	9.94905	0.88930	9.95169	0.89472	9.95425	0.90002	9.95674	0.90519	28
36	9	.94638	.88386	.94909	.88940	.95173	.89481	.95429	.90010	.95678	.90528	24
40	10	.94643	.88396	.94914	.88949	.95177	.89490	.95433	.90019	.95682	.90537	20
44	11	.94648	.88405	.94918	.88958	.95182	.89499	.95438	.90028	.95686	.90545	16
48	12	9.94652	0.88414	9.94923	0.88967	9.95186	0.89508	9.95442	0.90037	9.95690	0.90553	12
52	13	.94657	.88423	.94927	.88976	.95190	.89517	.95446	.90045	.95694	.90562	8
56	14	9.94661	0.88433	9.94932	0.88985	9.95195	0.89526	9.95450	0.90054	9.95699	0.90570	4
		$14^h 39^m$		$14^h 35^m$		$14^h 31^m$		$14^h 27^m$		$14^h 23^m$		

s	′	$9^h 21^m$	140°	$9^h 25^m$	141°	$9^h 29^m$	142°	$9^h 33^m$	143°	$9^h 37^m$	144°	s
0	15	9.94666	0.88442	9.94936	0.88994	9.95199	0.89534	9.95454	0.90063	9.95703	0.90579	60
4	16	.94670	.88451	.94941	.89003	.95203	.89543	.95459	.90071	.97507	.90588	56
8	17	.94675	.88461	.94945	.89012	.95208	.89552	.95463	.90080	.95711	.90596	52
12	18	.94680	.88470	.94950	.89022	.95212	.89561	.95467	.90089	.95715	.90604	48
16	19	9.94684	0.88479	9.94954	0.89031	9.95216	0.89570	9.95471	0.90097	9.95719	0.90613	44
20	20	.94689	.88489	.94958	.89040	.95221	.89579	.95475	.90106	.95723	.90621	40
24	21	.94693	.88498	.94963	.89049	.95225	.89588	.95480	.90115	.95727	.90630	36
28	22	.94698	.88507	.94967	.89058	.95229	.89597	.95484	.90124	.95731	.90638	32
32	23	9.94702	0.88516	9.94972	0.89067	o.95234	0.89606	9.95488	0.90132	9.95735	0.90647	28
36	24	.94707	.88526	.94976	.89076	.95238	.89614	.95492	.90141	.95739	.90655	24
40	25	.94711	.88535	.94981	.89085	.95242	.89623	.95496	.90150	.95743	.90664	20
44	26	.94716	.88544	.94985	.89094	.95246	.89632	.95501	.90158	.95747	.90672	16
48	27	9.94721	0.88553	9.94989	0.89103	9.95251	0.89641	9.95505	0.90167	9.95751	0.90680	12
52	28	.94725	.88563	.94994	.89112	.95255	.89650	.95509	.90176	.95755	.90689	8
56	29	9.94730	0.88572	9.94998	0.89121	9.95259	0.89659	9.95513	0.90184	9.95759	0.90697	4
		$14^h 38^m$		$14^h 34^m$		$14^h 30^m$		$14^h 26^m$		$14^h 22^m$		

s	′	$9^h 22^m$	140°	$9^h 26^m$	141°	$9^h 30^m$	142°	$9^h 34^m$	143°	$9^h 38^m$	144°	s
0	30	9.94734	0.88581	9.95003	0.89130	9.95264	0.89668	9.95517	0.90193	9.95763	0.90706	60
4	31	.94739	.88590	.95007	.89139	.95268	.89677	.95521	.90201	.95768	.90714	56
8	32	.94743	.88600	.95011	.89149	.95272	.89685	.95526	.90210	.95772	.90723	52
12	33	.94748	.88609	.95016	.89158	.95276	.89694	.95530	.90219	.95776	.90731	48
16	34	9.94752	0.88618	9.95020	0.89167	9.95281	0.89703	9.95534	0.90227	9.95780	0.90740	44
20	35	.94757	.88627	.95025	.89176	.95285	.89712	.95538	.90236	.95784	.90748	40
24	36	.94761	.88637	.95029	.89185	.95289	.89721	.95542	.90245	.95788	.90756	36
28	37	.94766	.88646	.95033	.89194	.95294	.89730	.95546	.90253	.95792	.90765	32
32	38	9.94770	0.88655	9.95038	0.89203	9.95298	0.89738	9.95550	0.90262	9.95796	0.90773	28
36	39	.94774	.88664	.95042	.89212	.95302	.89747	.95555	.90271	.95800	.90782	24
40	40	.94779	.88674	.95047	.89221	.95306	.89756	.95559	.90279	.95804	.90790	20
44	41	.94784	.88683	.95051	.89230	.95311	.89765	.95563	.90288	.95808	.90798	16
48	42	9.94788	0.88692	9.95055	0.89239	9.95315	0.89774	9.95567	0.90296	9.95812	0.90807	12
52	43	.94793	.88701	.95060	.89248	.95319	.89783	.95571	.90305	.95816	.90815	8
56	44	9.94797	0.88710	9.95064	0.89257	9.95323	0.89791	9.95575	0.90314	9.95820	0.90824	4
		$14^h 37^m$		$14^h 33^m$		$14^h 29^m$		$14^h 25^m$		$14^h 21^m$		

s	′	$9^h 23^m$	140°	$9^h 27^m$	141°	$9^h 31^m$	142°	$9^h 35^m$	143°	$9^h 39^m$	144°	s
0	45	9.94802	0.88720	9.95069	0.89266	9.95328	0.89800	9.95579	0.90322	9.95824	0.90832	60
4	46	.94806	.88729	.95073	.89275	.95332	.89809	.95584	.90331	.95828	.90840	56
8	47	.94811	.88738	.95077	.89284	.95336	.89818	.95588	.90339	.95832	.90849	52
12	48	.94815	.88747	.95082	.89293	.95340	.89827	.95592	.90348	.95836	.90857	48
16	49	9.94820	0.88756	9.95086	0.89302	9.75345	0.89835	9.95596	0.90357	9.95840	0.90866	44
20	50	.94824	.88766	.95090	.89311	.95349	.89844	.95600	.90365	.95844	.90874	40
24	51	.94829	.88775	.95095	.89320	.95353	.89853	.95604	.90374	.95848	.90882	36
28	52	.94833	.88784	.95099	.89329	.95357	.89862	.95608	.90382	.95852	.90891	32
32	53	9.94838	0.88793	9.95104	0.89338	9.95362	0.89870	9.95613	0.90391	9.95856	0.90899	28
36	54	.94842	.88802	.95108	.89347	.95366	.89879	.95617	.90399	.95860	.90907	24
40	55	.94847	.88811	.95112	.89356	.95370	.89888	.95621	.90408	.95864	.90916	20
44	56	.94851	.88821	.95117	.89365	.95374	.89897	.95625	.90417	.95868	.90924	16
48	57	9.94856	0.88830	9.95121	0.89374	9.95379	0.89906	9.95629	0.90425	9.95872	0.90932	12
52	58	.94860	.88839	.95125	.89383	.95383	.89914	.95633	.90434	.95876	.90941	8
56	59	.94865	.88848	.95130	.89392	.95387	.89923	.95637	.90442	.95880	.90949	4
60	60	9.94869	0.88857	9.95134	0.89401	9.95391	0.89932	9.95641	0.90451	9.95884	0.90958	0
		$14^h 36^m$		$14^h 32^m$		$14^h 28^m$		$14^h 24^m$		$14^h 20^m$		

TABLE 45.

Haversines.

		$10^h\ 0^m$	150°	$10^h\ 4^m$	151°	$10^h\ 8^m$	152°	$10^h\ 12^m$	153°	$10^h\ 16^m$	154°	
s	′	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	s
0	0	9.96989	0.93301	9.97188	0.93731	9.97381	0.94147	9.97566	0.94550	9.97745	0.94940	60
4	1	.96992	.93309	.97192	.93738	.97384	.94154	.97569	.95557	.97748	.94946	56
8	2	.96996	.93316	.97195	.93745	.97387	.94161	.97572	.94564	.97751	.94952	52
12	3	.96999	.93323	.97198	.93752	.97390	.94168	.97575	.94570	.97754	.94959	48
16	4	9.97002	0.93330	9.97201	0.93759	9.97393	0.94175	9.97578	0.94577	9.97756	0.94965	44
20	5	.97006	.93338	.97205	.93766	.97397	.94181	.97581	.94583	.97759	.94972	40
24	6	.97009	.93345	.97208	.93773	.97400	.94188	.97584	.94590	.97762	.94978	36
28	7	.97012	.93352	.97211	.93780	.97403	.94195	.97587	.94596	.97765	.94984	32
32	8	9.97016	0.93359	9.97214	0.93787	9.97406	0.94202	9.97591	0.94603	9.97768	0.94991	28
36	9	.97019	.93367	.97218	.93794	.97409	.94209	.97594	.94619	.97771	.94997	24
40	10	.97022	.93374	.97221	.93801	.97412	.94215	.97597	.94610	.97774	.95003	20
44	11	.97026	.93381	.97224	.93808	.97415	.94222	.97600	.94623	.97777	.95010	16
48	12	9.97029	0.93388	9.97227	0.93815	9.97418	0.94229	9.97603	0.94629	9.97780	0.95016	12
52	13	.97033	.93395	.97231	.93822	.97422	.94236	.97606	.94636	.97783	.95022	8
56	14	9.97036	0.93403	9.97234	0.93829	9.97425	0.94243	9.97609	0.94642	9.97785	0.95029	4
		$13^h\ 59^m$		$13^h\ 55^m$		$13^h\ 51^m$		$13^h\ 47^m$		$13^h\ 43^m$		

s	′	$10^h\ 1^m$	150°	$10^h\ 5^m$	151°	$10^h\ 9^m$	152°	$10^h\ 13^m$	153°	$10^h\ 17^m$	154°	s
0	15	9.97039	0.93410	9.97237	0.93836	9.97428	0.94249	9.97612	0.94649	9.97788	0.95035	60
4	16	.97043	.93417	.97240	.93843	.97431	.94256	.97615	.94655	.97791	.95041	56
8	17	.97046	.93424	.97244	.93850	.97434	.94263	.97618	.94662	.97794	.95048	52
12	18	.97049	.93432	.97247	.93857	.97437	.94270	.97621	.94669	.97797	.95054	48
16	19	9.97052	0.93439	9.97250	0.93864	9.97440	0.94276	9.97624	0.94675	9.97800	0.95060	44
20	20	.97056	.93446	.97253	.93871	.97443	.94283	.97627	.94682	.97803	.95066	40
24	21	.97059	.93453	.97257	.93878	.97447	.94290	.97630	.94688	.97806	.95073	36
28	22	.97063	.93460	.97260	.93885	.97450	.94297	.97633	.94695	.97808	.95079	32
32	23	9.97066	0.93468	9.97263	0.93892	9.97453	0.94303	9.97636	0.94701	9.97811	0.95085	28
36	24	.97069	.93475	.97266	.93899	.97456	.94310	.97639	.94708	.97814	.95092	24
40	25	.97073	.93482	.97269	.93906	.97459	.94317	.97642	.94714	.97817	.95098	20
44	26	.97076	.93489	.97273	.93913	.97462	.94324	.97645	.94721	.97820	.95104	16
48	27	9.97079	0.93496	9.97276	0.93920	9.97465	0.94330	9.97647	0.94727	9.97823	0.95111	12
52	28	.97083	.93503	.97279	.93927	.97468	.94337	.97650	.94734	.97826	.95117	8
56	29	9.97086	0.93511	9.97282	0.93934	9.97471	0.94344	9.97653	0.94740	9.97829	0.95123	4
		$13^h\ 58^m$		$13^h\ 54^m$		$13^h\ 50^m$		$13^h\ 46^m$		$13^h\ 42^m$		

s	′	$10^h\ 2^m$	150°	$10^h\ 6^m$	151°	$10^h\ 10^m$	152°	$10^h\ 14^m$	153°	$10^h\ 18^m$	154°	s
0	30	9.97089	0.93518	9.97285	0.93941	9.97474	0.94351	9.97656	0.94747	9.97831	0.95129	60
4	31	.97093	.93525	.97289	.93948	.97478	.94357	.97659	.94753	.97834	.95136	56
8	32	.97096	.93532	.97292	.93955	.97481	.94364	.97662	.94760	.97837	.95142	52
12	33	.97099	.93539	.97295	.93962	.97484	.94371	.97665	.94766	.97840	.95148	48
16	34	9.97103	0.93546	9.97298	0.93969	9.97487	0.94377	9.97668	0.94773	9.97843	0.95154	44
20	35	.97106	.93554	.97301	.93976	.97490	.94384	.97671	.94779	.97846	.95161	40
24	36	.97109	.93561	.97305	.93982	.97493	.94391	.97674	.94786	.97849	.95167	36
28	37	.97113	.93568	.97308	.93989	.97496	.94397	.97677	.94792	.97851	.95173	32
32	38	9.97116	0.93575	9.97311	0.93996	9.97499	0.94404	9.97680	0.94799	9.97854	0.95179	28
36	39	.97119	.93582	.97314	.94003	.97502	.94411	.97683	.94805	.97857	.95186	24
40	40	.97123	.93589	.97317	.94610	.97505	.94418	.97686	.94811	.97860	.95192	20
44	41	.97126	.93596	.97321	.94017	.97508	.94424	.97689	.94818	.97863	.95198	16
48	42	9.97129	0.93603	9.97324	0.94024	9.97511	0.94431	9.97692	0.94824	9.97866	0.95204	12
52	43	.97132	.93611	.97327	.94031	.97514	.94438	.97695	.94831	.97868	.95210	8
56	44	9.97136	0.93618	9.97330	0.94038	9.97518	0.94444	9.97698	0.94837	9.97871	0.95217	4
		$13^h\ 57^m$		$13^h\ 53^m$		$13^h\ 49^m$		$13^h\ 45^m$		$13^h\ 41^m$		

s	′	$10^h\ 3^m$	150°	$10^h\ 7^m$	151°	$10^h\ 11^m$	152°	$10^h\ 15^m$	153°	$10^h\ 19^m$	154°	s
0	45	9.97139	0.93625	9.97333	0.94045	9.97521	0.94451	9.97701	0.94844	9.97874	0.95223	60
4	46	.97142	.93632	.97337	.94051	.97524	.94458	.97704	.94850	.97877	.95229	56
8	47	.97146	.93639	.97340	.94058	.97527	.94464	.97707	.94857	.97880	.95235	52
12	48	.97149	.93646	.97343	.94065	.97530	.94471	.97710	.94863	.97883	.95241	48
16	49	9.97152	0.93653	9.97346	0.94072	9.97533	0.94477	9.97713	0.94869	9.97885	0.95248	44
20	50	.97156	.93660	.97349	.94079	.97536	.94484	.97716	.94876	.97888	.95254	40
24	51	.97159	.93667	.97352	.94086	.97539	.94491	.97718	.94882	.97891	.95260	36
28	52	.97162	.93674	.97356	.94093	.97542	.94497	.97721	.94889	.97894	.95266	32
32	53	9.97165	0.93682	9.97359	0.94099	9.97545	0.94504	9.97724	0.94895	9.97897	0.95273	28
36	54	.97169	.93689	.97362	.94106	.97548	.94511	.97727	.94901	.97899	.95278	24
40	55	.97172	.93696	.97365	.94113	.97551	.94517	.97730	.94908	.97902	.95285	20
44	56	.97175	.93703	.97368	.94120	.97554	.94524	.97733	.94914	.97905	.95291	16
48	57	9.97179	0.93710	9.97371	0.94127	9.97557	0.94531	9.97736	0.94921	9.97908	0.95297	12
52	58	.97182	.93717	.97575	.94134	.97560	.94537	.97739	.94927	.97911	.95303	8
56	59	.97185	.93724	.97378	.94141	.97563	.94544	.97742	.94933	.97914	.95309	4
60	60	9.97188	0.93731	9.97381	0.94147	9.97566	0.94550	9.97745	0.94940	9.97916	0.95315	0
		$13^h\ 56^m$		$13^h\ 52^m$		$13^h\ 48^m$		$13^h\ 44^m$		$13^h\ 40^m$		

TABLE 45.

Haversines:

s	′	$10^h\ 20^m$	**155°**	$10^h\ 24^m$	**156°**	$10^h\ 28^m$	**157°**	$10^h\ 32^m$	**158°**	$10^h\ 36^m$	**159°**	
		Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	s
0	**0**	9.97916	**0.95315**	9.98081	**0.95677**	9.98239	**0.96025**	9.98389	**0.96359**	9.98533	**0.96679**	60
4	**1**	.97919	**.95322**	.98084	**.95683**	.98241	**.96031**	.98392	**.96365**	.98536	**.96684**	56
8	**2**	.97922	**.95328**	.98086	**.95689**	.98244	**.96037**	.98394	**.96370**	.98538	**.96689**	52
12	**3**	.97925	**.95334**	.98089	**.95695**	.98246	**.96042**	.98397	**.96376**	.98540	**.96695**	48
16	**4**	9.97927	**0.95340**	9.98092	**0.95701**	9.98249	**0.96048**	9.98399	**0.96381**	9.98543	**0.96700**	44
20	**5**	.97930	**.95346**	.98094	**.95707**	.98251	**.96054**	.98402	**.96386**	.98545	**.96705**	40
24	**6**	.97933	**.95352**	.98097	**.95713**	.98254	**.96059**	.98404	**.96392**	.98547	**.96710**	36
28	**7**	.97936	**.95358**	.98100	**.95719**	.98256	**.96065**	.98406	**.96397**	.98550	**.96715**	32
32	**8**	9.97939	**0.95364**	9.98102	**0.95724**	9.98259	**0.96071**	9.98409	**0.96403**	9.98552	**0.96721**	28
36	**9**	.97941	**.95371**	.98105	**.95730**	.98262	**.96076**	.98411	**.96408**	.98554	**.96726**	24
40	**10**	.97944	**.95377**	.98108	**.95736**	.98264	**.96082**	.98414	**.96413**	.98557	**.96731**	20
44	**11**	.97947	**.95383**	.98110	**.95742**	.98267	**.96088**	.98416	**.96419**	.98559	**.96736**	16
48	**12**	9.97950	**0.95389**	9.98113	**0.95748**	9.98269	**0.96093**	9.98419	**0.96424**	9.98561	**0.96741**	12
52	**13**	.97953	**.95395**	.98116	**.95754**	.98272	**.96099**	.98421	**.96430**	.98564	**.96746**	8
56	**14**	9.97955	**0.95401**	9.98118	**0.95760**	9.98274	**0.96104**	9.98424	**0.96435**	9.98566	**0.96752**	4
		$13^h\ 39^m$		$13^h\ 35^m$		$13^h\ 31^m$		$13^h\ 27^m$		$13^h\ 23^m$		

s	′	$10^h\ 21^m$	**155°**	$10^h\ 25^m$	**156°**	$10^h\ 29^m$	**157°**	$10^h\ 33^m$	**158°**	$10^h\ 37^m$	**159°**	s
0	**15**	9.97958	**0.95407**	9.98121	**0.95766**	9.98277	**0.96110**	9.98426	**0.96440**	9.98568	**0.96757**	60
4	**16**	.97961	**.95413**	.98124	**.95771**	.98279	**.96116**	.98428	**.96446**	.98570	**.96762**	56
8	**17**	.97964	**.95419**	.98126	**.95777**	.98282	**.96121**	.98431	**.96451**	.98573	**.96767**	52
12	**18**	.97966	**.95425**	.98129	**.95783**	.98285	**.96127**	.98433	**.96457**	.98575	**.96772**	48
16	**19**	9.97969	**0.95431**	9.98132	**0.95789**	9.98287	**0.96133**	9.98436	**0.96462**	9.98577	**0.96777**	44
20	**20**	.97972	**.95438**	.98134	**.95795**	.98290	**.96138**	.98438	**.96467**	.98580	**.96782**	40
24	**21**	.97975	**.95444**	.98137	**.95801**	.98292	**.96144**	.98440	**.96473**	.98582	**.96788**	36
28	**22**	.97977	**.95450**	.98139	**.95806**	.98295	**.96149**	.98443	**.96478**	.98584	**.96793**	32
32	**23**	9.97980	**0.95456**	9.98142	**0.95812**	9.98297	**0.96155**	9.98455	**0.96483**	9.98587	**0.96798**	28
36	**24**	.97983	**.95462**	.98145	**.95818**	.98300	**.96161**	.98448	**.96488**	.98589	**.96803**	24
40	**25**	.97986	**.95468**	.98147	**.95824**	.98302	**.96166**	.98450	**.96494**	.98591	**.96808**	20
44	**26**	.97988	**.95474**	.98150	**.95830**	.98305	**.96172**	.98453	**.96500**	.98593	**.96813**	16
48	**27**	9.97991	**0.95480**	9.98153	**0.95836**	9.98307	**0.96177**	9.98455	**0.96505**	9.98596	**0.96818**	12
52	**28**	.97994	**.95486**	.98155	**.95841**	.98310	**.96183**	.98457	**.96510**	.98598	**.96823**	8
56	**29**	9.97997	**0.95492**	9.98158	**0.95847**	9.98312	**0.96188**	9.98460	**0.96516**	9.98600	**0.96829**	4
		$13^h\ 38^m$		$13^h\ 34^m$		$13^h\ 30^m$		$13^h\ 26^m$		$13^h\ 22^m$		

s	′	$10^h\ 22^m$	**155°**	$10^h\ 26^m$	**156°**	$10^h\ 30^m$	**157°**	$10^h\ 34^m$	**158°**	$10^h\ 38^m$	**159°**	s
0	**30**	9.97999	**0.95498**	9.98161	**0.95853**	9.98315	**0.96194**	9.98462	**0.96521**	9.98603	**0.96834**	60
4	**31**	.98002	**.95504**	.98163	**.95859**	.98317	**.96200**	.98465	**.96526**	.98605	**.96839**	56
8	**32**	.98005	**.95510**	.98166	**.95865**	.98320	**.96205**	.98467	**.96532**	.98607	**.96844**	52
12	**33**	.98008	**.95516**	.98168	**.95870**	.98322	**.96211**	.98469	**.96537**	.98609	**.96849**	48
16	**34**	9.98010	**0.95522**	9.98171	**0.95876**	9.98325	**0.96216**	9.98472	**0.96542**	9.98612	**0.96854**	44
20	**35**	.98013	**.95528**	.98174	**.95882**	.98327	**.96222**	.98474	**.96547**	.98614	**.96859**	40
24	**36**	.98016	**.95534**	.98176	**.95888**	.98330	**.96227**	.98476	**.96553**	.98616	**.96864**	36
28	**37**	.98019	**.95540**	.98179	**.95894**	.98332	**.96233**	.98479	**.96558**	.98619	**.96869**	32
32	**38**	9.98021	**0.95546**	9.98182	**0.95899**	9.98335	**0.96238**	9.98481	**0.96563**	9.98621	**0.96874**	28
36	**39**	.98024	**.95552**	.98184	**.95905**	.98337	**.96244**	.98484	**.96569**	.98623	**.96879**	24
40	**40**	.98027	**.95558**	.98187	**.95911**	.98340	**.96249**	.98486	**.96574**	.98625	**.96884**	20
44	**41**	.98030	**.95564**	.98189	**.95917**	.98342	**.96255**	.98488	**.96579**	.98628	**.96889**	16
48	**42**	9.98032	**0.95570**	9.98192	**0.95922**	9.98345	**0.96260**	9.98491	**0.96585**	9.98630	**0.96894**	12
52	**43**	.98035	**.95576**	.98195	**.95928**	.98347	**.96266**	.98493	**.96590**	.98632	**.96899**	8
56	**44**	9.98038	**0.95582**	9.98197	**0.95934**	9.98350	**0.96272**	9.98496	**0.96595**	9.98634	**0.96905**	4
		$13^h\ 37^m$		$13^h\ 33^m$		$13^h\ 29^m$		$13^h\ 25^m$		$13^h\ 21^m$		

s	′	$10^h\ 23^m$	**155°**	$10^h\ 27^m$	**156°**	$10^h\ 31^m$	**157°**	$10^h\ 35^m$	**158°**	$10^h\ 39^m$	**159°**	s
0	**45**	9.98040	**0.95588**	9.98200	**0.95940**	9.98352	**0.96277**	9.98498	**0.96600**	9.98637	**0.96910**	60
4	**46**	.98043	**.95594**	.98202	**.95945**	.98355	**.96283**	.98500	**.96606**	.98639	**.96915**	56
8	**47**	.98046	**.95600**	.98205	**.95951**	.98357	**.96288**	.98503	**.96611**	.98641	**.96920**	52
12	**48**	.98049	**.95606**	.98208	**.95957**	.98360	**.96294**	.98505	**.96616**	.98643	**.96925**	48
16	**49**	9.98051	**0.95612**	9.98210	**0.95962**	9.98362	**0.96299**	9.98507	**0.96621**	9.98646	**0.96930**	44
20	**50**	.98054	**.95618**	.98213	**.95968**	.98365	**.96305**	.98510	**.96627**	.98648	**.96935**	40
24	**51**	.98057	**.95624**	.98215	**.95974**	.98367	**.96310**	.98512	**.96632**	.98650	**.96940**	36
28	**52**	.98059	**.95630**	.98218	**.95980**	.98370	**.96315**	.98514	**.96637**	.98652	**.96945**	32
32	**53**	9.98062	**0.95636**	9.98221	**0.95985**	9.98372	**0.96321**	9.98517	**0.96642**	9.98655	**0.96950**	28
36	**54**	.98065	**.95642**	.98223	**.95991**	.98375	**.96326**	.98519	**.96648**	.98657	**.96955**	24
40	**55**	.98067	**.95648**	.98226	**.95997**	.98377	**.96332**	.98521	**.96653**	.98659	**.96960**	20
44	**56**	.98070	**.95654**	.98228	**.96002**	.98379	**.96337**	.98524	**.96658**	.98661	**.96965**	16
48	**57**	9.98073	**0.95660**	9.98231	**0.96008**	9.98382	**0.96343**	9.98526	**0.96663**	9.98664	**0.96970**	12
52	**58**	.98076	**.95665**	.98233	**.96014**	.98384	**.96348**	.98529	**.96669**	.98666	**.96975**	8
56	**59**	.98078	**.95671**	.98236	**.96020**	.98387	**.96354**	.98531	**.96674**	.98668	**.96980**	4
60	**60**	9.98081	**0.95677**	9.98239	**0.96025**	9.98389	**0.96359**	9.98533	**0.96679**	9.98670	**0.96985**	0
		$13^h\ 36^m$		$13^h\ 32^m$		$13^h\ 28^m$		$13^h\ 24^m$		$13^h\ 20^m$		

TABLE 45.

Haversines.

s	′	$10^h\,40^m$ 160°		$10^h\,44^m$ 161°		$10^h\,48^m$ 162°		$10^h\,52^m$ 163°		$10^h\,56^m$ 164°		s
		Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	
0	0	9.98670	0.96985	9.98801	0.97276	9.98924	0.97553	9.99041	0.97815	9.99151	0.98063	60
4	1	.98673	.96990	.98803	.97281	.98926	.97557	.99043	.97819	.99152	.98067	56
8	2	.98675	.96995	.98805	.97285	.98928	.97562	.99044	.97824	.99154	.98071	52
12	3	.98677	.97000	.98807	.97290	.98930	.97566	.99046	.97828	.99156	.98075	48
16	4	9.98679	0.97005	9.98809	0.97295	9.98932	0.97571	9.99048	0.97832	9.99158	0.98079	44
20	5	.98681	.97009	.98811	.97300	.98934	.97575	.99050	.97836	.99159	.98083	40
24	6	.98684	.97014	.98813	.97304	.98936	.97580	.99052	.97841	.99161	.98087	36
28	7	.98686	.97019	.98815	.97309	.98938	.97584	.99054	.97845	.99163	.98091	32
32	8	9.98688	0.97024	9.98817	0.97314	9.98940	0.97589	9.99056	0.97849	9.99165	0.98095	28
36	9	.98690	.97029	.98819	.97318	.98942	.97593	.99058	.97853	.99166	.98099	24
40	10	.98692	.97034	.98822	.97323	.98944	.97598	.99059	.97858	.99168	.98103	20
44	11	.98695	.97039	.98824	.97328	.98946	.97602	.99061	.97862	.99170	.98107	16
48	12	9.98697	0.97044	9.98826	0.97332	9.98948	0.97606	9.99063	0.97866	9.99172	0.98111	12
52	13	.98699	.97049	.98828	.97337	.98950	.97611	.99065	.97870	.99173	.98115	8
56	14	9.98701	0.97054	9.98830	0.97342	9.98952	0.97615	9.99067	0.97874	9.99175	0.98119	4
		$13^h\,19^m$		$13^h\,15^m$		$13^h\,11^m$		$13^h\,7^m$		$13^h\,3^m$		

s	′	$10^h\,41^m$ 160°		$10^h\,45^m$ 161°		$10^h\,49^m$ 162°		$10^h\,53^m$ 163°		$10^h\,57^m$ 164°		s
0	15	9.98703	0.97059	9.98832	0.97347	9.98954	0.97620	9.99069	0.97879	9.99177	0.98123	60
4	16	.98706	.97064	.98834	.97351	.98956	.97624	.99071	.97883	.99179	.98127	56
8	17	.98708	.97069	.98836	.97356	.98958	.97629	.99072	.97887	.99180	.98131	52
12	18	.98710	.97074	.98838	.97361	.98960	.97633	.99074	.97891	.99182	.98135	48
16	19	9.98712	0.97078	9.98840	0.97365	9.98962	0.97637	9.99076	0.97895	9.99184	0.98139	44
20	20	.98714	.97083	.98842	.97370	.98964	.97642	.99078	.97899	.99186	.98142	40
24	21	.98717	.97088	.98845	.97374	.98966	.97646	.99080	.97904	.99187	.98146	36
28	22	.98719	.97093	.98847	.97379	.98968	.97651	.99082	.97908	.99189	.98150	32
32	23	9.98721	0.97098	9.98849	0.97384	9.98970	0.97655	9.99084	0.97912	9.99191	0.98154	28
36	24	.98723	.97103	.98851	.97388	.98971	.97660	.99085	.97916	.99193	.98158	24
40	25	.98725	.97108	.98853	.97393	.98973	.97664	.99087	.97920	.99194	.98162	20
44	26	.98728	.97113	.98855	.97398	.98975	.97668	.99089	.97924	.99196	.98166	16
48	27	9.98730	0.97117	9.98857	0.97402	9.98977	0.97673	9.99091	0.97929	9.99198	0.98170	12
52	28	.98732	.97122	.98859	.97407	.98979	.97677	.99093	.97933	.99200	.98174	8
56	29	9.98734	0.97127	9.98861	0.97412	9.98981	0.97681	9.99095	0.97937	9.99201	0.98178	4
		$13^h\,18^m$		$13^h\,14^m$		$13^h\,10^m$		$13^h\,6^m$		$13^h\,2^m$		

s	′	$10^h\,42^m$ 160°		$10^h\,46^m$ 161°		$10^h\,50^m$ 162°		$10^h\,54^m$ 163°		$10^h\,58^m$ 164°		s
0	30	9.98736	0.97132	9.98863	0.97416	9.98983	0.97686	9.99096	0.97941	9.99203	0.98182	60
4	31	.98738	.97137	.98865	.97421	.98985	.97690	.99098	.97945	.99205	.98185	56
8	32	.98741	.97142	.98867	.97425	.98987	.97695	.99100	.97949	.99206	.98189	52
12	33	.98743	.97147	.98869	.97430	.98989	.97699	.99102	.97953	.99208	.98193	48
16	34	9.98745	0.97151	9.98871	0.97435	9.98991	0.97703	9.99104	0.97957	9.99210	0.98197	44
20	35	.98747	.97156	.98873	.97439	.98993	.97708	.99106	.97962	.99212	.98201	40
24	36	.98749	.97161	.98875	.97444	.98995	.97712	.99107	.97966	.99213	.98205	36
28	37	.98751	.97166	.98877	.97448	.98997	.97716	.99109	.97970	.99215	.98209	32
32	38	9.98754	0.97171	9.98880	0.97453	9.98999	0.97721	9.99111	0.97974	9.99217	0.98213	28
36	39	.98756	.97176	.98882	.97458	.99001	.97725	.99113	.97978	.99218	.98216	24
40	40	.98758	.97180	.98884	.97462	.99003	.97729	.99115	.97982	.99220	.98220	20
44	41	.98760	.97185	.98886	.97467	.99004	.97734	.99116	.97986	.99222	.98224	16
48	42	9.98762	0.97190	9.98888	0.97471	9.99006	0.97738	9.99118	0.97990	9.99223	0.98228	12
52	43	.98764	.97195	.98890	.97476	.99008	.97742	.99120	.97994	.99225	.98232	8
56	44	9.98766	0.97200	9.98892	0.97480	9.99010	0.97747	9.99122	0.97998	9.99227	0.98236	4
		$13^h\,17^m$		$13^h\,13^m$		$13^h\,9^m$		$13^h\,5^m$		$13^h\,1^m$		

s	′	$10^h\,43^m$ 160°		$10^h\,47^m$ 161°		$10^h\,51^m$ 162°		$10^h\,55^m$ 163°		$10^h\,59^m$ 164°		s
0	45	9.98769	0.97204	9.98894	0.97485	9.99012	0.97751	9.99124	0.98002	9.99229	0.98239	60
4	46	.98771	.97209	.98896	.97490	.99014	.97755	.99126	.98007	.99230	.98243	56
8	47	.98773	.97214	.98898	.97494	.99016	.97760	.99127	.98011	.99232	.98247	52
12	48	.98775	.97219	.98900	.97499	.99018	.97764	.99129	.98015	.99234	.98251	48
16	49	9.98777	0.97224	9.98902	0.97503	9.99020	0.97768	9.99131	0.98019	9.99235	0.98255	44
20	50	98779	.97228	.98904	.97508	.99022	.97773	.99133	.98023	.99237	.98258	40
24	51	.98781	.97233	.98906	.97512	.99024	.97777	.99135	.98027	.99239	.98262	36
28	52	.98784	.97238	.98908	.97517	.99026	.97781	.99136	.98031	.99240	.98266	32
32	53	9.98786	0.97243	9.98910	0.97521	9.99027	0.97785	9.99138	0.98035	9.99242	0.98270	28
36	54	.98788	.97247	.98912	.97526	.99029	.97790	.99140	.98039	.99244	.98274	24
40	55	.98790	.97252	.98914	.97530	.99031	.97794	.99142	.98043	.99245	.98277	20
44	56	.98792	.97257	.98916	.97535	.99033	.97798	.99143	.98047	.99247	.98281	16
48	57	9.98794	0.97262	9.98918	0.97539	9.99035	0.97802	9.99145	0.98051	9.99249	0.98285	12
52	58	.98796	.97266	.98920	.97544	.99037	.97807	.99147	.98055	.99250	.98289	8
56	59	.98798	.97271	.98922	.97548	.99039	.97811	.99149	.98059	.99252	.98293	4
60	60	9.98801	0.97276	9.98924	0.97553	9.99041	0.97815	9.99151	0.98063	9.99254	0.98296	0
		$13^h\,16^m$		$13^h\,12^m$		$13^h\,8^m$		$13^h\,4^m$		$13^h\,0^m$		

TABLE 45.

Haversines.

s	′	$11^h 20^m$	170°	$11^h 24^m$	171°	$11^h 28^m$	172°	$11^h 32^m$	173°	$11^h 36^m$	174°	
s	′	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	Log. Hav.	Nat. Hav.	s
0	0	9.99669	0.99240	9.99732	0.99384	9.99788	0.99513	9.99838	0.99627	9.99881	0.99726	60
4	1	.99670	.99243	.99733	.99387	.99789	.99515	.99839	.99629	.99882	.99728	56
8	2	.99671	.99245	.99734	.99389	.99790	.99517	.99839	.99631	.99882	.99729	52
12	3	.99672	.99248	.99735	.99391	.99791	.99519	.99840	.99633	.99883	.99731	48
16	4	9.99673	0.99250	9.99736	0.99393	9.99792	0.99521	9.99841	0.99634	9.99884	0.99732	44
20	5	.99674	.99253	.99737	.99396	.99793	.99523	.99842	.99636	.99884	.99734	40
24	6	.99675	.99255	.99738	.99398	.99793	.99525	.99842	.99638	.99885	.99735	36
28	7	.99677	.99258	.99739	.99400	.99794	.99527	.99843	.99640	.99885	.99737	32
32	8	9.99678	0.99260	9.99740	0.99402	9.99795	0.99529	9.99844	0.99641	9.99886	0.99738	28
36	9	.99679	.99263	.99741	.99405	.99796	.99531	.99845	.99643	.99887	.99740	24
40	10	.99680	.99265	.99742	.99407	.99797	.99533	.99845	.99645	.99887	.99741	20
44	11	.99681	.99268	.99743	.99409	.99798	.99535	.99846	.99647	.99888	.99743	16
48	12	9.99682	0.99270	9.99744	0.99411	9.99799	0.99537	9.99847	0.99648	9.99889	0.99744	12
52	13	.99683	.99273	.99745	.99414	.99800	.99539	.99848	.99650	.99889	.99746	8
56	14	9.99684	0.99275	9.99746	0.99416	9.99800	0.99541	9.99848	0.99652	9.99890	0.99747	4
		$12^h 39^m$		$12^h 35^m$		$12^h 31^m$		$12^h 27^m$		$12^h 23^m$		

s	′	$11^h 21^m$	170°	$11^h 25^m$	171°	$11^h 29^m$	172°	$11^h 33^m$	173°	$11^h 37^m$	174°	s
0	15	9.99685	0.99278	9.99747	0.99418	9.99801	0.99543	9.99849	0.99653	9.99891	0.99748	60
4	16	.99686	.99280	.99748	.99420	.99802	.99545	.99850	.99655	.99891	.99750	56
8	17	.99687	.99283	.99748	.99422	.99803	.99547	.99851	.99657	.99892	.99751	52
12	18	.99688	.99285	.99749	.99425	.99804	.99549	.99851	.99659	.99893	.99753	48
16	19	9.99690	0.99288	9.99750	0.99427	9.99805	0.99551	9.99852	0.99660	9.99893	0.99754	44
20	20	.99691	.99290	.99751	.99429	.99805	.99553	.99853	.99662	.99894	.99756	40
24	21	.99692	.99292	.99752	.99431	.99806	.99555	.99854	.99664	.99894	.99757	36
28	22	.99693	.99295	.99753	.99433	.99807	.99557	.99854	.99665	.99895	.99759	32
32	23	9.99694	0.99297	9.99754	0.99436	9.99808	0.99559	9.99855	0.99667	9.99896	0.99760	28
36	24	.99695	.99299	.99755	.99438	.99809	.99561	.99856	.99669	.99896	.99761	24
40	25	.99696	.99302	.99756	.99440	.99810	.99563	.99857	.99670	.99897	.99763	20
44	26	.99697	.99305	.99757	.99442	.99811	.99565	.99857	.99672	.99897	.99764	16
48	27	9.99698	0.99307	9.99758	0.99444	9.99811	0.99567	9.99858	0.99674	9.99898	0.99766	12
52	28	.99699	.99309	.99759	.99446	.99812	.99568	.99859	.99675	.99899	.99767	8
56	29	9.99700	0.99312	9.99760	0.99449	9.99813	0.99570	9.99859	0.99677	9.99899	0.99768	4
		$12^h 38^m$		$12^h 34^m$		$12^h 30^m$		$12^h 26^m$		$12^h 22^m$		

s	′	$11^h 22^m$	170°	$11^h 26^m$	171°	$11^h 30^m$	172°	$11^h 34^m$	173°	$11^h 38^m$	174°	s
0	30	9.99701	0.99314	9.99761	0.99451	9.99814	0.99572	9.99860	0.99679	9.99900	0.99770	60
4	31	.99702	.99317	.99762	.99453	.99815	.99574	.99861	.99680	.99901	.99771	56
8	32	.99703	.99319	.99763	.99455	.99815	.99576	.99862	.99682	.99901	.99773	52
12	33	.99704	.99321	.99764	.99457	.99816	.99578	.99862	.99684	.99902	.99774	48
16	34	9.99705	0.99324	9.99765	0.99459	9.99817	0.99580	9.99863	0.99685	9.99902	0.99775	44
20	35	.99706	.99326	.99766	.99461	.99818	.99582	.99864	.99687	.99903	.99777	40
24	36	.99707	.99329	.99766	.99464	.99819	.99584	.99864	.99688	.99904	.99778	36
28	37	.99708	.99331	.99767	.99466	.99820	.99585	.99865	.99690	.99904	.99780	32
32	38	9.99710	0.99333	9.99768	0.99468	9.99820	0.99587	9.99866	0.99692	9.99905	0.99781	28
36	39	.99711	.99336	.99769	.99470	.99821	.99589	.99867	.99693	.99905	.99782	24
40	40	.99712	.99338	.99770	.99472	.99822	.99591	.99867	.99695	.99906	.99784	20
44	41	.99713	.99340	.99771	.99474	.99823	.99593	.99868	.99696	.99906	.99785	16
48	42	9.99714	0.99343	9.99772	0.99476	9.99824	0.99595	9.99869	0.99698	9.99907	0.99786	12
52	43	.99715	.99345	.99773	.99478	.99824	.99597	.99869	.99700	.99908	.99788	8
56	44	9.99716	0.99347	9.99774	0.99480	9.99825	0.99598	9.99870	0.99701	9.99908	0.99789	4
		$12^h 37^m$		$12^h 33^m$		$12^h 29^m$		$12^h 25^m$		$12^h 21^m$		

s	′	$11^h 23^m$	170°	$11^h 27^m$	171°	$11^h 31^m$	172°	$11^h 35^m$	173°	$11^h 39^m$	174°	s
0	45	9.99717	0.99350	9.99774	0.99483	9.99826	0.99600	9.99871	0.99703	9.99909	0.99790	60
4	46	.99718	.99352	.99775	.99485	.99827	.99602	.99871	.99704	.99909	.99792	56
8	47	.99719	.99354	.99776	.99487	.99828	.99604	.99872	.99706	.99910	.99793	52
12	48	.99720	.99357	.99777	.99489	.99828	.99606	.99873	.99708	.99911	.99794	48
16	49	9.99721	0.99359	9.99778	0.99491	9.99829	0.99608	9.99874	0.99709	9.99911	0.99796	44
20	50	.99722	.99361	.99779	.99493	.99830	.99609	.99874	.99711	.99912	.99797	40
24	51	.99723	.99364	.99780	.99495	.99831	.99611	.99875	.99712	.99912	.99798	36
28	52	.99724	.99366	.99781	.99497	.99832	.99613	.99876	.99714	.99913	.99799	32
32	53	9.99725	0.99368	9.99782	0.99499	9.99832	0.99615	9.99876	0.99715	9.99913	0.99801	28
36	54	.99726	.99371	.99783	.99501	.99833	.99617	.99877	.99717	.99914	.99802	24
40	55	.99727	.99373	.99784	.99503	.99834	.99618	.99878	.99719	.99915	.99803	20
44	56	.99728	.99375	.99785	.99505	.99835	.99620	.99878	.99720	.99915	.99805	16
48	57	9.99729	0.99378	9.99786	0.99507	9.99836	0.99622	9.99879	0.99722	9.99916	0.99806	12
52	58	.99730	.99380	.99786	.99509	.99836	.99624	.99880	.99723	.99916	.99807	8
56	59	.99731	.99382	.99787	.99511	.99837	.99626	.99880	.99725	.99917	.99808	4
60	60	9.99732	0.99384	9.99788	0.99513	9.99838	0.99627	9.99881	0.99726	9.99917	0.99810	0
		$12^h 36^m$		$12^h 32^m$		$12^h 28^m$		$12^h 24^m$		$12^h 20^m$		

TABLE 46.

Corrections* to be Applied to the Observed Altitude of a Star or of the Sun's Lower Limb, to Find the True Altitude.

OBS. ALT.	HEIGHT OF THE EYE.											
	8 Feet.		9 Feet.		10 Feet.		11 Feet.		12 Feet.		13 Feet.	
	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)
° ′	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″
6 30	5 29	10 40	5 19	10 50	5 09	11 00	5 00	11 09	4 51	11 18	4 43	11 26
40	5 39	10 30	5 29	10 40	5 19	10 50	5 10	10 59	5 01	11 08	4 53	11 16
50	5 49	10 20	5 39	10 30	5 29	10 40	5 20	10 49	5 11	10 58	5 03	11 06
7 00	5 59	10 10	5 49	10 20	5 39	10 30	5 30	10 39	5 21	10 48	5 13	10 56
10	6 08	10 01	5 58	10 11	5 48	10 21	5 39	10 30	5 30	10 39	5 22	10 47
20	6 17	9 52	6 07	10 02	5 57	10 12	5 48	10 21	5 39	10 30	5 31	10 38
7 30	6 26	9 43	6 16	9 53	6 06	10 03	5 57	10 12	5 48	10 21	5 40	10 29
40	6 34	9 35	6 24	9 45	6 14	9 55	6 05	10 04	5 56	10 13	5 48	10 21
50	6 42	9 27	6 32	9 37	6 22	9 47	6 13	9 56	6 04	10 05	5 56	10 13
8 00	6 50	9 19	6 40	9 29	6 30	9 39	6 21	9 48	6 12	9 57	6 04	10 05
10	6 57	9 12	6 47	9 22	6 37	9 32	6 28	9 41	6 19	9 50	6 11	9 58
20	7 04	9 05	6 54	9 15	6 44	9 25	6 35	9 34	6 26	9 43	6 18	9 51
8 30	7 11	8 58	7 01	9 08	6 51	9 18	6 42	9 27	6 33	9 36	6 25	9 44
40	7 18	8 51	7 08	9 01	6 58	9 11	6 49	9 20	6 40	9 29	6 32	9 37
50	7 24	8 45	7 14	8 55	7 04	9 05	6 55	9 14	6 46	9 23	6 38	9 31
9 00	7 30	8 39	7 20	8 49	7 10	8 59	7 01	9 08	6 52	9 17	6 44	9 25
20	7 42	8 27	7 32	8 37	7 22	8 47	7 13	8 56	7 04	9 05	6 56	9 13
40	7 53	8 16	7 43	8 26	7 33	8 36	7 24	8 45	7 15	8 54	7 07	9 02
10 00	8 04	8 05	7 54	8 15	7 44	8 25	7 35	8 34	7 26	8 43	7 18	8 51
20	8 14	7 55	8 04	8 05	7 54	8 15	7 45	8 24	7 36	8 33	7 28	8 41
40	8 23	7 46	8 13	7 56	8 03	8 06	7 54	8 15	7 45	8 24	7 37	8 32
11 00	8 32	7 37	8 22	7 47	8 12	7 57	8 03	8 06	7 54	8 15	7 46	8 23
30	8 44	7 25	8 34	7 35	8 24	7 45	8 15	7 54	8 06	8 03	7 58	8 11
12 00	8 55	7 14	8 45	7 24	8 35	7 34	8 26	7 43	8 17	7 52	8 09	8 00
30	9 06	7 03	8 56	7 13	8 46	7 23	8 37	7 32	8 28	7 41	8 20	7 49
13 00	9 16	6 53	9 06	7 03	8 56	7 13	8 47	7 22	8 38	7 31	8 30	7 39
30	9 25	6 44	9 15	6 54	9 05	7 04	8 56	7 13	8 47	7 22	8 39	7 30
14 00	9 33	6 36	9 23	6 46	9 13	6 56	9 04	7 05	8 55	7 14	8 47	7 22
15 00	9 49	6 20	9 39	6 30	9 29	6 40	9 20	6 49	9 11	6 58	9 03	7 06
16 00	10 02	6 07	9 52	6 17	9 42	6 27	9 33	6 36	9 24	6 45	9 16	6 53
17 00	10 15	5 54	10 05	6 04	9 55	6 14	9 46	6 23	9 37	6 32	9 29	6 40
18 00	10 25	5 44	10 15	5 54	10 05	6 04	9 56	6 13	9 47	6 22	9 39	6 30
19 00	10 35	5 34	10 25	5 44	10 15	5 54	10 06	6 03	9 57	6 12	9 49	6 20
20 00	10 43	5 25	10 33	5 35	10 23	5 45	10 14	5 54	10 05	6 03	9 57	6 11
22 00	10 59	5 09	10 49	5 19	10 39	5 29	10 30	5 38	10 21	5 47	10 13	5 55
24 00	11 12	4 56	11 02	5 06	10 52	5 16	10 43	5 25	10 34	5 34	10 26	5 42
26 00	11 23	4 45	11 13	4 55	11 03	5 05	10 54	5 14	10 45	5 23	10 37	5 31
28 00	11 33	4 35	11 23	4 45	11 13	4 55	11 04	5 04	10 55	5 13	10 47	5 21
30 00	11 41	4 27	11 31	4 37	11 21	4 47	11 12	4 56	11 03	5 05	10 55	5 13
32 00	11 49	4 19	11 39	4 29	11 29	4 39	11 20	4 48	11 11	4 57	11 03	5 05
34 00	11 56	4 12	11 46	4 22	11 36	4 32	11 27	4 41	11 18	4 50	11 10	4 [illegible]
36 00	12 02	4 06	11 52	4 16	11 42	4 26	11 33	4 35	11 24	4 44	11 16	4 [illegible]
38 00	12 07	4 01	11 57	4 11	11 47	4 21	11 38	4 30	11 29	4 39	11 21	4 47
40 00	12 12	3 55	12 02	4 05	11 52	4 15	11 43	4 24	11 34	4 33	11 26	4 41
45 00	12 23	3 44	12 13	3 54	12 03	4 04	11 54	4 13	11 45	4 22	11 37	4 [illegible]
50 00	12 31	3 35	12 21	3 45	12 11	3 55	12 02	4 04	11 53	4 13	11 45	4 21
55 00	12 38	3 27	12 28	3 37	12 18	3 47	12 09	3 56	12 00	4 05	11 52	4 [illegible]
60 00	12 44	3 20	12 34	3 30	12 24	3 40	12 15	3 49	12 06	3 58	11 58	4 [illegible]
65 00	12 51	3 13	12 41	3 23	12 31	3 33	12 22	3 42	12 13	3 51	12 05	3 [illegible]
70 00	12 56	3 07	12 46	3 17	12 36	3 27	12 27	3 36	12 18	3 45	12 10	3 [illegible]
75 00	13 00	3 02	12 50	3 12	12 40	3 22	12 31	3 31	12 22	3 40	12 14	3 [illegible]
80 00	13 06	2 56	12 56	3 06	12 46	3 16	12 37	3 25	12 28	3 34	12 20	3 [illegible]
85 00	13 10	2 51	13 00	3 01	12 50	3 11	12 41	3 20	12 32	3 29	12 24	3 37
90 00	13 14	2 46	13 04	2 56	12 54	3 06	12 45	3 15	12 36	3 24	12 28	3 [illegible]

ADDITIONAL CORR. FOR SUN'S ALT.	Day of Month.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
		″	″	″	″	″	″	″	″	″	″	″	″
	1st to 15th....	+18	+15	+8	0	− 8	−13	−14	−11	−5	+3	+11	+[illegible]
	16th to 31st...	+17	+12	+4	−4	−11	−14	−13	− 9	−1	+7	+14	+[illegible]

* The corrections for the observed altitude of a Star or Planet involves the dip and the refraction; and for the observed altitude of the Sun's lower limb, the dip, refraction, parallax, and mean semidiameter, which is taken as 16′. A supplementary correction taking account of the variation of the Sun's semidiameter in the different months of the year is given at the foot of the main table.

TABLE 46

Corrections to be Applied to the Observed Altitude of a
the True Altitude—Co

Obs. Alt.	HEIGHT OF T					
	14 Feet.		15 Feet.		16 Feet.	
	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)
° ′	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″
6 30	4 35	11 34	4 27	11 42	4 20	11 49
40	4 45	11 24	4 37	11 32	4 30	11 39
50	4 55	11 14	4 47	11 22	4 40	11 29
7 00	5 05	11 04	4 57	11 12	4 50	11 19
10	5 14	10 55	5 06	11 03	4 59	11 10
20	5 23	10 46	5 15	10 54	5 08	11 01
7 30	5 32	10 37	5 24	10 45	5 17	10 52
40	5 40	10 29	5 32	10 37	5 25	10 44
50	5 48	10 21	5 40	10 29	5 33	10 36
8 00	5 56	10 13	5 48	10 21	5 41	10 28
10	6 03	10 06	5 55	10 14	5 48	10 21
20	6 10	9 59	6 02	10 07	5 55	10 14
8 30	6 17	9 52	6 09	10 00	6 02	10 07
40	6 24	9 45	6 16	9 53	6 09	10 00
50	6 30	9 39	6 22	9 47	6 15	9 54
9 00	6 36	9 33	6 28	9 41	6 21	9 48
20	6 48	9 21	6 40	9 29	6 33	9 36
40	6 59	9 10	6 51	9 18	6 44	9 25
10 00	7 10	8 59	7 02	9 07	6 55	9 14
20	7 20	8 49	7 12	8 57	7 05	9 04
40	7 29	8 40	7 21	8 48	7 14	8 55
11 00	7 38	8 31	7 30	8 39	7 23	8 46
30	7 50	8 19	7 42	8 27	7 35	8 34
12 00	8 01	8 08	7 53	8 16	7 46	8 23
30	8 12	7 57	8 04	8 05	7 57	8 12
13 00	8 22	7 47	8 14	7 55	8 07	8 02
30	8 31	7 38	8 23	7 46	8 16	7 53
14 00	8 39	7 30	8 31	7 38	8 24	7 45
15 00	8 55	7 14	8 47	7 22	8 40	7 29
16 00	9 08	7 01	9 00	7 09	8 53	7 16
17 00	9 21	6 48	9 13	6 56	9 06	7 03
18 00	9 31	6 38	9 23	6 46	9 16	6 53
19 00	9 41	6 28	9 33	6 36	9 26	6 43
20 00	9 49	6 19	9 41	6 27	9 34	6 34
22 00	10 05	6 03	9 57	6 11	9 50	6 18
24 00	10 18	5 50	10 10	5 58	10 03	6 05
26 00	10 29	5 39	10 21	5 47	10 14	5 54
28 00	10 39	5 29	10 31	5 37	10 24	5 44
30 00	10 47	5 21	10 39	5 29	10 32	5 36
32 00	10 55	5 13	10 47	5 21	10 40	5 28
34 00	11 02	5 06	10 54	5 14	10 47	5 21
36 00	11 08	5 00	11 00	5 08	10 53	5 15
38 00	11 13	4 55	11 05	5 03	10 58	5 10
40 00	11 18	4 49	11 10	4 57	11 03	5 04
45 00	11 29	4 38	11 21	4 46	11 14	4 53
50 00	11 37	4 29	11 29	4 37	11 22	4 44
55 00	11 44	4 21	11 36	4 29	11 29	4 36
60 00	11 50	4 14	11 42	4 22	11 35	4 29
65 00	11 57	4 07	11 49	4 15	11 42	4 22
70 00	12 02	4 01	11 54	4 09	11 47	4 16
75 00	12 06	3 56	11 58	4 04	11 51	4 11
80 00	12 12	3 50	12 04	3 58	11 57	4 05
85 00	12 16	3 45	12 08	3 53	12 01	4 00
90 00	12 20	3 40	12 12	3 48	12 05	3 55

Additional Corr. for Sun's Alt.	Day of Month.	Jan.	Feb.	Mar.	Apr.
		″	″	″	″
	1st to 15th....	+18	+15	+8	0
	16th to 31st...	+17	+12	+4	−4

* The corrections for the observed altitude of a Star or Planet involves t
of the Sun's lower limb, the dip, refraction, parallax, and mean semidiamet
taking account of the variation of the Sun's semidiameter in the different n

TABLE 46.

Corrections to be Applied to the Observed Altitude of a Star or of the Sun's Lower Limb, to Find the True Altitude—Continued.

Obs. Alt.	HEIGHT OF THE EYE.											
	20 Feet.		21 Feet.		22 Feet.		23 Feet.		24 Feet.		25 Feet.	
	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)
° ′	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″
6 30	3 52	12 17	3 46	12 23	3 39	12 30	3 33	12 36	3 27	12 42	3 21	12 48
40	4 .2	12 07	3 56	12 13	3 49	12 20	3 43	12 26	3 37	12 32	3 31	12 38
50	4 12	11 57	4 06	12 03	3 59	12 10	3 53	12 16	3 47	12 22	3 41	12 28
7 00	4 22	11 47	4 16	11 53	4 09	12 00	4 03	12 06	3 57	12 12	3 51	12 18
10	4 31	11 38	4 25	11 44	4 18	11 51	4 12	11 57	4 06	12 03	4 00	12 09
20	4 40	11 29	4 34	11 35	4 27	11 42	4 21	11 48	4 15	11 54	4 09	12 00
7 30	4 49	11 20	4 43	11 26	4 36	11 33	4 30	11 39	4 24	11 45	4 18	11 51
40	4 57	11 12	4 51	11 18	4 44	11 25	4 38	11 31	4 32	11 37	4 26	11 43
50	5 05	11 04	4 59	11 10	4 52	11 17	4 46	11 23	4 40	11 29	4 34	11 35
8 00	5 13	10 56	5 07	11 02	5 00	11 09	4 54	11 15	4 48	11 21	4 42	11 27
10	5 20	10 49	5 14	10 55	5 07	11 02	5 01	11 08	4 55	11 14	4 49	11 20
20	5 27	10 42	5 21	10 48	5 14	10 55	5 08	11 01	5 02	11 07	4 56	11 13
8 30	5 34	10 35	5 28	10 41	5 21	10 48	5 15	10 54	5 09	11 00	5 03	11 06
40	5 41	10 28	5 35	10 34	5 28	10 41	5 22	10 47	5 16	10 53	5 10	10 59
50	5 47	10 22	5 41	10 28	5 34	10 35	5 28	10 41	5 22	10 47	5 16	10 53
9 00	5 53	10 16	5 47	10 22	5 40	10 29	5 34	10 35	5 28	10 41	5 22	10 47
20	6 05	10 04	5 59	10 10	5 52	10 17	5 46	10 23	5 40	10 29	5 34	10 35
40	6 16	9 53	6 10	9 59	6 03	10 06	5 57	10 12	5 51	10 18	5 45	10 24
10 00	6 27	9 42	6 21	9 48	6 14	9 55	6 08	10 01	6 02	10 07	5 56	10 13
20	6 37	9 32	6 31	9 38	6 24	9 45	6 18	9 51	6 12	9 57	6 06	10 03
40	6 46	9 23	6 40	9 29	6 33	9 36	6 27	9 42	6 21	9 48	6 15	9 54
11 00	6 55	9 14	6 49	9 20	6 42	9 27	6 36	9 33	6 30	9 39	6 24	9 45
30	7 07	9 02	7 01	9 08	6 54	9 15	6 48	9 21	6 42	9 27	6 36	9 33
12 00	7 18	8 51	7 12	8 57	7 05	9 04	6 59	9 10	6 53	9 16	6 47	9 22
30	7 29	8 40	7 23	8 46	7 16	8 53	7 10	8 59	7 04	9 05	6 58	9 11
13 00	7 39	8 30	7 33	8 36	7 26	8 43	7 20	8 49	7 14	8 55	7 08	9 01
30	7 48	8 21	7 42	8 27	7 35	8 34	7 29	8 40	7 23	8 46	7 17	8 52
14 00	7 56	8 13	7 50	8 19	7 43	8 26	7 37	8 32	7 31	8 38	7 25	8 44
15 00	8 12	7 57	8 06	8 03	7 59	8 10	7 53	8 16	7 47	8 22	7 41	8 28
16 00	8 25	7 44	8 19	7 50	8 12	7 57	8 06	8 03	8 00	8 09	7 54	8 15
17 00	8 38	7 31	8 32	7 37	8 25	7 44	8 19	7 50	8 13	7 56	8 07	8 02
18 00	8 48	7 21	8 42	7 27	8 35	7 34	8 29	7 40	8 23	7 46	8 17	7 52
19 00	8 58	7 11	8 52	7 17	8 45	7 24	8 39	7 30	8 33	7 36	8 27	7 42
20 00	9 06	7 02	9 00	7 08	8 53	7 15	8 47	7 21	8 41	7 27	8 35	7 33
22 00	9 22	6 46	9 16	6 52	9 09	6 59	9 03	7 05	8 57	7 11	8 51	7 17
24 00	9 35	6 33	9 29	6 39	9 22	6 46	9 16	6 52	9 10	6 58	9 04	7 04
26 00	9 46	6 22	9 40	6 28	9 33	6 35	9 27	6 41	9 21	6 47	9 15	6 53
28 00	9 56	6 12	9 50	6 18	9 43	6 25	9 37	6 31	9 31	6 37	9 25	6 43
30 00	10 04	6 04	9 58	6 10	9 51	6 17	9 45	6 23	9 39	6 29	9 33	6 35
32 00	10 12	5 56	10 06	6 02	9 59	6 09	9 53	6 15	9 47	6 21	9 41	6 27
34 00	10 19	5 49	10 13	5 55	10 06	6 02	10 00	6 08	9 54	6 14	9 48	6 20
36 00	10 25	5 43	10 19	5 49	10 12	5 56	10 06	6 02	10 00	6 08	9 54	6 14
38 00	10 30	5 38	10 24	5 44	10 17	5 51	10 11	5 57	10 05	6 03	9 59	6 09
40 00	10 35	5 32	10 29	5 38	10 22	5 45	10 16	5 51	10 10	5 57	10 04	6 03
45 00	10 46	5 21	10 40	5 27	10 33	5 34	10 27	5 40	10 21	5 46	10 15	5 52
50 00	10 54	5 12	10 48	5 18	10 41	5 25	10 35	5 31	10 29	5 37	10 23	5 43
55 00	11 01	5 04	10 55	5 10	10 48	5 17	10 42	5 23	10 36	5 29	10 30	5 35
60 00	11 07	4 57	11 01	5 03	10 54	5 10	10 48	5 16	10 42	5 22	10 36	5 28
65 00	11 14	4 50	11 08	4 56	11 01	5 03	10 55	5 09	10 49	5 15	10 43	5 21
70 00	11 19	4 44	11 13	4 50	11 06	4 57	11 00	5 03	10 54	5 09	10 48	5 15
75 00	11 23	4 39	11 17	4 45	11 10	4 52	11 04	4 58	10 58	5 04	10 52	5 10
80 00	11 29	4 33	11 23	4 39	11 16	4 46	11 10	4 52	11 04	4 58	10 58	5 04
85 00	11 33	4 28	11 27	4 34	11 20	4 41	11 14	4 47	11 08	4 53	11 02	4 59
90 00	11 37	4 23	11 31	4 29	11 24	4 36	11 18	4 42	11 12	4 48	11 06	4 54

Additional Corr. for Sun's Alt.	Day of Month.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
		″	″	″	″	″	″	″	″	″	″	″	″
	1st to 15th....	+18	+15	+8	0	−8	−13	−14	−11	−5	+3	+11	+16
	16th to 31st...	+17	+12	+4	−4	−11	−14	−13	−9	−1	+7	+14	+18

* The corrections for the observed altitude of a Star or Planet involves the dip and the refraction; and for the observed altitude of the Sun's lower limb, the dip, refraction, parallax, and mean semidiameter, which is taken as 16′. A supplementary correction taking account of the variation of the Sun's semidiameter in the different months of the year is given at the foot of the main table.

TABLE 46.

Corrections* to be Applied to the Observed Altitude of a Star o the True Altitude—Continued

Obs. Alt.	HEIGHT OF THE					
	26 Feet.		27 Feet.		28 Feet.	
	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)
° ′	′ ′	′ ″	′ ″	′ ″	′ ″	′ ″
6 30	3 15	12 54	3 09	13 00	3 04	13 05
40	3 25	12 44	3 19	12 50	3 14	12 55
50	3 35	12 34	3 29	12 40	3 24	12 45
7 00	3 45	12 24	3 39	12 30	3 34	12 35
10	3 54	12 15	3 48	12 21	3 43	12 26
20	4 03	12 06	3 57	12 12	3 52	12 17
7 30	4 12	11 57	4 06	12 03	4 01	12 08
40	4 20	11 49	4 14	11 55	4 09	12 00
50	4 28	11 41	4 22	11 47	4 17	11 52
8 00	4 36	11 33	4 30	11 39	4 25	11 44
10	4 43	11 26	4 37	11 32	4 32	11 37
20	4 50	11 19	4 44	11 25	4 39	11 30
8 30	4 57	11 12	4 51	11 18	4 46	11 23
40	5 04	11 05	4 58	11 11	4 53	11 16
50	5 10	10 59	5 04	11 05	4 59	11 10
9 00	5 16	10 53	5 10	10 59	5 05	11 04
20	5 28	10 41	5 22	10 47	5 17	10 52
40	5 39	10 30	5 33	10 36	5 28	10 41
10 00	5 50	10 19	5 44	10 25	5 39	10 30
20	6 00	10 09	5 54	10 15	5 49	10 20
40	6 09	10 00	6 03	10 06	5 58	10 11
11 00	6 18	9 51	6 12	9 57	6 07	10 02
30	6 30	9 39	6 24	9 45	6 19	9 50
12 00	6 41	9 28	6 35	9 34	6 30	9 39
30	6 52	9 17	6 46	9 23	6 41	9 28
13 00	7 02	9 07	6 56	9 13	6 51	9 18
30	7 11	8 58	7 05	9 04	7 00	9 09
14 00	7 19	8 50	7 13	8 56	7 08	9 01
15 00	7 35	8 34	7 29	8 40	7 24	8 45
16 00	7 48	8 21	7 42	8 27	7 37	8 32
17 00	8 01	8 08	7 55	8 14	7 50	8 19
18 00	8 11	7 58	8 05	8 04	8 00	8 09
19 00	8 21	7 48	8 15	7 54	8 10	7 59
20 00	8 29	7 39	8 23	7 45	8 18	7 50
22 00	8 45	7 23	8 39	7 29	8 34	7 34
24 00	8 58	7 10	8 52	7 16	8 47	7 21
26 00	9 09	6 59	9 03	7 05	8 58	7 10
28 00	9 19	6 49	9 13	6 55	9 08	7 00
30 00	9 27	6 41	9 21	6 47	9 16	6 52
32 00	9 35	6 33	9 29	6 39	9 24	6 44
34 00	9 42	6 26	9 36	6 32	9 31	6 37
36 00	9 48	6 20	9 42	6 26	9 37	6 31
38 00	9 53	6 15	9 47	6 21	9 42	6 26
40 00	9 58	6 09	9 52	6 15	9 47	6 20
45 00	10 09	5 58	10 03	6 04	9 58	6 09
50 00	10 17	5 49	10 11	5 55	10 06	6 00
55 00	10 24	5 41	10 18	5 47	10 13	5 52
60 00	10 30	5 34	10 24	5 40	10 19	5 45
65 00	10 37	5 27	10 31	5 33	10 26	5 38
70 00	10 42	5 21	10 36	5 27	10 31	5 32
75 00	10 46	5 16	10 40	5 22	10 35	5 27
80 00	10 52	5 10	10 46	5 16	10 41	5 21
85 00	10 56	5 05	10 50	5 11	10 45	5 16
90 00	11 00	5 00	10 54	5 06	10 49	5 11

	Day of Month.	Jan.	Feb.	Mar.	Apr.	May.	Ju
Additional Corr. for Sun's Alt.		″	″	″	″	″	
	1st to 15th....	+18	+15	+8	0	− 8	−1
	16th to 31st...	+17	+12	+4	−4	−11	−1

* The corrections for the observed altitude of a Star or Planet involves the dip ar of the Sun's lower limb, the dip, refraction, parallax, and mean semidiameter, whicl taking account of the variation of the Sun's semidiameter in the different months of

TABLE 46.

Corrections to be Applied to the Observed Altitude of a Star or of the Sun's Lower Limb, to Find the True Altitude—Continued.

Obs. Alt.	HEIGHT OF THE EYE.									
	31 Feet.		32 Feet.		33 Feet.		34 Feet.		35 Feet.	
	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)
° ′	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″
6 30	2 48	13 21	2 42	13 27	2 37	13 32	2 32	13 37	2 27	13 42
40	2 58	13 11	2 52	13 17	2 47	13 22	2 42	13 27	2 37	13 32
50	3 08	13 01	3 02	13 07	2 57	13 12	2 52	13 17	2 47	13 22
7 00	3 18	12 51	3 12	12 57	3 07	13 02	3 02	13 07	2 57	13 12
10	3 27	12 42	3 21	12 48	3 16	12 53	3 11	12 58	3 06	13 03
20	3 36	12 33	3 30	12 39	3 25	12 44	3 20	12 49	3 15	12 54
7 30	3 45	12 24	3 39	12 30	3 34	12 35	3 29	12 40	3 24	12 45
40	3 53	12 16	3 47	12 22	3 42	12 27	3 37	12 32	3 32	12 37
50	4 01	12 08	3 55	12 14	3 50	12 19	3 45	12 24	3 40	12 29
8 00	4 09	12 00	4 03	12 06	3 58	12 11	3 53	12 16	3 48	12 21
10	4 16	11 53	4 10	11 59	4 05	12 04	4 00	12 09	3 55	12 14
20	4 23	11 46	4 17	11 52	4 12	11 57	4 07	12 02	4 02	12 07
8 30	4 30	11 39	4 24	11 45	4 19	11 50	4 14	11 55	4 09	12 00
40	4 37	11 32	4 31	11 38	4 26	11 43	4 21	11 48	4 16	11 53
50	4 43	11 26	4 37	11 32	4 32	11 37	4 27	11 42	4 22	11 47
9 00	4 49	11 20	4 43	11 26	4 38	11 31	4 33	11 36	4 28	11 41
20	5 01	11 08	4 55	11 14	4 50	11 19	4 45	11 24	4 40	11 29
40	5 12	10 57	5 06	11 03	5 01	11 08	4 56	11 13	4 51	11 18
10 00	5 23	10 46	5 17	10 52	5 12	10 57	5 07	11 02	5 02	11 07
20	5 33	10 36	5 27	10 42	5 22	10 47	5 17	10 52	5 12	10 57
40	5 42	10 27	5 36	10 33	5 31	10 38	5 26	10 43	5 21	10 48
11 00	5 51	10 18	5 45	10 24	5 40	10 29	5 35	10 34	5 30	10 39
30	6 03	10 06	5 57	10 12	5 52	10 17	5 47	10 22	5 42	10 27
12 00	6 14	9 55	6 08	10 01	6 03	10 06	5 58	10 11	5 53	10 16
30	6 25	9 44	6 19	9 50	6 14	9 55	6 09	10 00	6 04	10 05
13 00	6 35	9 34	6 29	9 40	6 24	9 45	6 19	9 50	6 14	9 55
30	6 44	9 25	6 38	9 31	6 33	9 36	6 28	9 41	6 23	9 46
14 00	6 52	9 17	6 46	9 23	6 41	9 28	6 36	9 33	6 31	9 38
15 00	7 08	9 01	7 02	9 07	6 57	9 12	6 52	9 17	6 47	9 22
16 00	7 21	8 48	7 15	8 54	7 10	8 59	7 05	9 04	7 00	9 09
17 00	7 34	8 35	7 28	8 41	7 23	8 46	7 18	8 51	7 13	8 56
18 00	7 44	8 25	7 38	8 31	7 33	8 36	7 28	8 41	7 23	8 46
19 00	7 54	8 15	7 48	8 21	7 43	8 26	7 38	8 31	7 33	8 36
20 00	8 02	8 06	7 56	8 12	7 51	8 17	7 46	8 22	7 41	8 27
22 00	8 18	7 50	8 12	7 56	8 07	8 01	8 02	8 06	7 57	8 11
24 00	8 31	7 37	8 25	7 43	8 20	7 48	8 15	7 53	8 10	7 58
26 00	8 42	7 26	8 36	7 32	8 31	7 37	8 26	7 42	8 21	7 47
28 00	8 52	7 16	8 46	7 22	8 41	7 27	8 36	7 32	8 31	7 37
30 00	9 00	7 08	8 54	7 14	8 49	7 19	8 44	7 24	8 39	7 29
32 00	9 08	7 00	9 02	7 06	8 57	7 11	8 52	7 16	8 47	7 21
34 00	9 15	6 53	9 09	6 59	9 04	7 04	8 59	7 09	8 54	7 14
36 00	9 21	6 47	9 15	6 53	9 10	6 58	9 05	7 03	9 00	7 08
38 00	9 26	6 42	9 20	6 48	9 15	6 53	9 10	6 58	9 05	7 03
40 00	9 31	6 36	9 25	6 42	9 20	6 47	9 15	6 52	9 10	6 57
45 00	9 42	6 25	9 36	6 31	9 31	6 36	9 26	6 41	9 21	6 46
50 00	9 50	6 16	9 44	6 22	9 39	6 27	9 34	6 32	9 29	6 37
55 00	9 57	6 08	9 51	6 14	9 46	6 19	9 41	6 24	9 36	6 29
60 00	10 03	6 01	9 57	6 07	9 52	6 12	9 47	6 17	9 42	6 22
65 00	10 10	5 54	10 04	6 00	9 59	6 05	9 54	6 10	9 49	6 15
70 00	10 15	5 48	10 09	5 54	10 04	5 59	9 59	6 04	9 54	6 09
75 00	10 19	5 43	10 13	5 49	10 08	5 54	10 03	5 59	9 58	6 04
80 00	10 25	5 37	10 19	5 43	10 14	5 48	10 09	5 53	10 04	5 58
85 00	10 29	5 32	10 23	5 38	10 18	5 43	10 13	5 48	10 08	5 53
90 00	10 33	5 27	10 27	5 33	10 22	5 38	10 17	5 43	10 12	5 48

	Day of Month.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Additional Corr. for Sun's Alt.		″	″	″	″	″	″	″	″	″	″	″	″
	1st to 15th....	+18	+15	+8	0	− 8	−13	−14	−11	−5	+3	+11	+16
	16th to 31st...	+17	+12	+4	−4	−11	−14	−13	− 9	−1	+7	+14	+18

* The corrections for the observed altitude of a Star or Planet involves the dip and the refraction; and for the observed altitude of the Sun's lower limb, the dip, refraction, parallax, and mean semidiameter, which is taken as 16′. A supplementary correction taking account of the variation of the Sun's semidiameter in the different months of the year is given at the foot of the main table.

TABLE 46.

Corrections* to be Applied to the Observed Altitude of a Star or of the Sun's Lower Limb, to Find the True Altitude—Continued.

Obs. Alt.	HEIGHT OF THE EYE. 41 Feet.		42 Feet.		43 Feet.		44 Feet.		45 Feet.		46 Feet.	
	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)
° ′	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″
6 30	1 58	14 11	1 54	14 15	1 49	14 20	1 44	14 25	1 39	14 30	1 35	14 34
40	2 08	14 01	2 04	14 05	1 59	14 10	1 54	14 15	1 49	14 20	1 45	14 24
50	2 18	13 51	2 14	13 55	2 09	14 00	2 04	14 05	1 59	14 10	1 55	14 14
7 00	2 28	13 41	2 24	13 45	2 19	13 50	2 14	13 55	2 09	14 00	2 05	14 04
10	2 37	13 32	2 33	13 36	2 28	13 41	2 23	13 46	2 18	13 51	2 14	13 55
20	2 46	13 23	2 42	13 27	2 37	13 32	2 32	13 37	2 27	13 42	2 23	13 46
7 30	2 55	13 14	2 51	13 18	2 46	13 23	2 41	13 28	2 36	13 33	2 32	13 37
40	3 03	13 06	2 59	13 10	2 54	13 15	2 49	13 20	2 44	13 25	2 40	13 29
50	3 11	12 58	3 07	13 02	3 02	13 07	2 57	13 12	2 52	13 17	2 48	13 21
8 00	3 19	12 50	3 15	12 54	3 10	12 59	3 05	13 04	3 00	13 09	2 56	13 13
10	3 26	12 43	3 22	12 47	3 17	12 52	3 12	12 57	3 07	13 02	3 03	13 06
20	3 33	12 36	3 29	12 40	3 24	12 45	3 19	12 50	3 14	12 55	3 10	12 59
8 30	3 40	12 29	3 36	12 33	3 31	12 38	3 26	12 43	3 21	12 48	3 17	12 52
40	3 47	12 22	3 43	12 26	3 38	12 31	3 33	12 36	3 28	12 41	3 24	12 45
50	3 53	12 16	3 49	12 20	3 44	12 25	3 39	12 30	3 34	12 35	3 30	12 39
9 00	3 59	12 10	3 55	12 14	3 50	12 19	3 45	12 24	3 40	12 29	3 36	12 33
20	4 11	11 58	4 07	12 02	4 02	12 07	3 57	14 12	3 52	12 17	3 48	12 21
40	4 22	11 47	4 18	11 51	4 13	11 56	4 08	12 01	4 03	12 06	3 59	12 10
10 00	4 33	11 36	4 29	11 40	4 24	11 45	4 19	11 50	4 14	11 55	4 10	11 59
20	4 43	11 26	4 39	11 30	4 34	11 35	4 29	11 40	4 24	11 45	4 20	11 49
40	4 52	11 17	4 48	11 21	4 43	11 26	4 38	11 31	4 33	11 36	4 29	11 40
11 00	5 01	11 08	4 57	11 12	4 52	11 17	4 47	11 22	4 42	11 27	4 38	11 31
30	5 13	10 56	5 09	11 00	5 04	11 05	4 59	11 10	4 54	11 15	4 50	11 19
12 00	5 24	10 45	5 20	10 49	5 15	10 54	5 10	10 59	5 05	11 04	5 01	11 08
30	5 35	10 34	5 31	10 38	5 26	10 43	5 21	10 48	5 16	10 53	5 12	10 57
13 00	5 45	10 24	5 41	10 28	5 36	10 33	5 31	10 38	5 26	10 43	5 22	10 47
30	5 54	10 15	5 50	10 19	5 45	10 24	5 40	10 29	5 35	10 34	5 31	10 38
14 00	6 02	10 07	5 58	10 11	5 53	10 16	5 48	10 21	5 43	10 26	5 39	10 30
15 00	6 18	9 51	6 14	9 55	6 09	10 00	6 04	10 05	5 59	10 10	5 55	10 14
16 00	6 31	9 38	6 27	9 42	6 22	9 47	6 17	9 52	6 12	9 57	6 08	10 01
17 00	6 44	9 25	6 40	9 29	6 35	9 34	6 30	9 39	6 25	9 44	6 21	9 48
18 00	6 54	9 15	6 50	9 19	6 45	9 24	6 40	9 29	6 35	9 34	6 31	9 38
19 00	7 04	9 05	7 00	9 09	6 55	9 14	6 50	9 19	6 45	9 24	6 41	9 28
20 00	7 12	8 56	7 08	9 00	7 03	9 05	6 58	9 10	6 53	9 15	6 49	9 19
22 00	7 28	8 40	7 24	8 44	7 19	8 49	7 14	8 54	7 09	8 59	7 05	9 03
24 00	7 41	8 27	7 37	8 31	7 32	8 36	7 27	8 41	7 22	8 46	7 18	8 50
26 00	7 52	8 16	7 48	8 20	7 43	8 25	7 38	8 30	7 33	8 35	7 29	8 39
28 00	8 02	8 06	7 58	8 10	7 53	8 15	7 48	8 20	7 43	8 25	7 39	8 29
30 00	8 10	7 58	8 06	8 02	8 01	8 07	7 56	8 12	7 51	8 17	7 47	8 21
32 00	8 18	7 50	8 14	7 54	8 09	7 59	8 04	8 04	7 59	8 09	7 55	8 13
34 00	8 25	7 43	8 21	7 47	8 16	7 52	8 11	7 57	8 06	8 02	8 02	8 06
36 00	8 31	7 37	8 27	7 41	8 22	7 46	8 17	7 51	8 12	7 56	8 08	8 00
38 00	8 36	7 32	8 32	7 36	8 27	7 41	8 22	7 46	8 17	7 51	8 13	7 55
40 00	8 41	7 26	8 37	7 30	8 32	7 35	8 27	7 40	8 22	7 45	8 18	7 49
45 00	8 52	7 15	8 48	7 19	8 43	7 24	8 38	7 29	8 33	7 34	8 29	7 38
50 00	9 00	7 06	8 56	7 10	8 51	7 15	8 46	7 20	8 41	7 25	8 37	7 29
55 00	9 07	6 58	9 03	7 02	8 58	7 07	8 53	7 12	8 48	7 17	8 44	7 21
60 00	9 13	6 51	9 09	6 55	9 04	7 00	8 59	7 05	8 54	7 10	8 50	7 14
65 00	9 20	6 44	9 16	6 48	9 11	6 53	9 06	6 58	9 01	7 03	8 57	7 07
70 00	9 25	6 38	9 21	6 42	9 16	6 47	9 11	6 52	9 06	6 57	9 02	7 01
75 00	9 29	6 33	9 25	6 37	9 20	6 42	9 15	6 47	9 10	6 52	9 06	6 56
80 00	9 35	6 27	9 31	6 31	9 26	6 36	9 21	6 41	9 16	6 46	9 12	6 50
85 00	9 39	6 22	9 35	6 26	9 30	6 31	9 25	6 36	9 20	6 41	9 16	6 45
90 00	9 43	6 17	9 39	6 21	9 34	6 26	9 29	6 31	9 24	6 36	9 20	6 40

ADDITIONAL CORR. FOR SUN'S ALT.	Day of Month.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
		″	″	″	″	″	″	″	″	″	″	″	″
	1st to 15th....	+18	+15	+8	0	− 8	−13	−14	−11	−5	+3	+11	+16
	16th to 31st...	+17	+12	+4	−4	−11	−14	−13	− 9	−1	+7	+14	+18

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* The corrections for the observed altitude of a Star or Planet involves the dip and the refraction; and for the observed altitude of the Sun's lower limb, the dip, refraction, parallax, and mean semidiameter, which is taken as 16′. A supplementary correction taking account of the variation of the Sun's semidiameter in the different months of the year is given at the foot of the main table.

TABLE 46.

Corrections* to be Applied to the Observed Altitude of a Star or of the Sun's Lower Limb, to Find the True Altitude—Continued.

Obs. Alt.	Height of the Eye.											
	53 Feet.		54 Feet.		55 Feet.		56 Feet.		57 Feet.		58 Feet.	
	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)
° ′	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″
6 30	1 07	15 02	1 03	15 06	0 59	15 10	0 55	15 14	0 51	15 18	0 48	15 21
40	1 17	14 52	1 13	14 56	1 09	15 00	1 05	15 04	1 01	15 08	0 58	15 11
50	1 27	14 42	1 23	14 46	1 19	14 50	1 15	14 54	1 11	14 58	1 08	15 01
7 00	1 37	14 32	1 33	14 36	1 29	14 40	1 25	14 44	1 21	14 48	1 18	14 51
10	1 46	14 23	1 42	14 27	1 38	14 31	1 34	14 35	1 30	14 39	1 27	14 42
20	1 55	14 14	1 51	14 18	1 47	14 22	1 43	14 26	1 39	14 30	1 36	14 33
7 30	2 04	14 05	2 00	14 09	1 56	14 13	1 52	14 17	1 48	14 21	1 45	14 24
40	2 12	13 57	2 08	14 01	2 04	14 05	2 00	14 09	1 56	14 13	1 53	14 16
50	2 20	13 49	2 16	13 53	2 12	13 57	2 08	14 01	2 04	14 05	2 01	14 08
8 00	2 28	13 41	2 24	13 45	2 20	13 49	2 16	13 53	2 12	13 57	2 09	14 00
10	2 35	13 34	2 31	13 38	2 27	13 42	2 23	13 46	2 19	13 50	2 16	13 53
20	2 42	13 27	2 38	13 31	2 34	13 35	2 30	13 39	2 26	13 43	2 23	13 46
8 30	2 49	13 20	2 45	13 24	2 41	13 28	2 37	13 32	2 33	13 36	2 30	13 39
40	2 56	13 13	2 52	13 17	2 48	13 21	2 44	13 25	2 40	13 29	2 37	13 32
50	3 02	13 07	2 58	13 11	2 54	13 15	2 50	13 19	2 46	13 23	2 43	13 26
9 00	3 08	13 01	3 04	13 05	3 00	13 09	2 56	13 13	2 52	13 17	2 49	13 20
20	3 20	12 49	3 16	12 53	3 12	12 57	3 08	13 01	3 04	13 05	3 01	13 08
40	3 31	12 38	3 27	12 42	3 23	12 46	3 19	12 50	3 15	12 54	3 12	12 57
10 00	3 42	12 27	3 38	12 31	3 34	12 35	3 30	12 39	3 26	12 43	3 23	12 46
20	3 52	12 17	3 48	12 21	3 44	12 25	3 40	12 29	3 36	12 33	3 33	12 36
40	4 01	12 08	3 57	12 12	3 53	12 16	3 49	12 20	3 45	12 24	3 42	12 27
11 00	4 10	11 59	4 06	12 03	4 02	12 07	3 58	12 11	3 54	12 15	3 51	12 18
30	4 22	11 47	4 18	11 51	4 14	11 55	4 10	11 59	4 06	12 03	4 03	12 06
12 00	4 33	11 36	4 29	11 40	4 25	11 44	4 21	11 48	4 17	11 52	4 14	11 55
30	4 44	11 25	4 40	11 29	4 36	11 33	4 32	11 37	4 28	11 41	4 25	11 44
13 00	4 54	11 15	4 50	11 19	4 46	11 23	4 42	11 27	4 38	11 31	4 35	11 34
30	5 03	11 06	4 59	11 10	4 55	11 14	4 51	11 18	4 47	11 22	4 44	11 25
14 00	5 11	10 58	5 07	11 02	5 03	11 06	4 59	11 10	4 55	11 14	4 52	11 17
15 00	5 27	10 42	5 23	10 46	5 19	10 50	5 15	10 54	5 11	10 58	5 08	11 01
16 00	5 40	10 29	5 36	10 33	5 32	10 37	5 28	10 41	5 24	10 45	5 21	10 48
17 00	5 53	10 16	5 49	10 20	5 45	10 24	5 41	10 28	5 37	10 32	5 34	10 35
18 00	6 03	10 06	5 59	10 10	5 55	10 14	5 51	10 18	5 47	10 22	5 44	10 25
19 00	6 13	9 56	6 09	10 00	6 05	10 04	6 01	10 08	5 57	10 12	5 54	10 15
20 00	6 21	9 47	6 17	9 51	6 13	9 55	6 09	9 59	6 05	10 03	6 02	10 06
22 00	6 37	9 31	6 33	9 35	6 29	9 39	6 25	9 43	6 21	9 47	6 18	9 50
24 00	6 50	9 18	6 46	9 22	6 42	9 26	6 38	9 30	6 34	9 34	6 31	9 37
26 00	7 01	9 07	6 57	9 11	6 53	9 15	6 49	9 19	6 45	9 23	6 42	9 26
28 00	7 11	8 57	7 07	9 01	7 03	9 05	6 59	9 09	6 55	9 13	6 52	9 16
30 00	7 19	8 49	7 15	8 53	7 11	8 57	7 07	9 01	7 03	9 05	7 00	9 08
32 00	7 27	8 41	7 23	8 45	7 19	8 49	7 15	8 53	7 11	8 57	7 08	9 00
34 00	7 34	8 34	7 30	8 38	7 26	8 42	7 22	8 46	7 18	8 50	7 15	8 53
36 00	7 40	8 28	7 36	8 32	7 32	8 36	7 28	8 40	7 24	8 44	7 21	8 47
38 00	7 45	8 23	7 41	8 27	7 37	8 31	7 33	8 35	7 29	8 39	7 26	8 42
40 00	7 50	8 17	7 46	8 21	7 42	8 25	7 38	8 29	7 34	8 33	7 31	8 36
45 00	8 01	8 06	7 57	8 10	7 53	8 14	7 49	8 18	7 45	8 22	7 42	8 25
50 00	8 09	7 57	8 05	8 01	8 01	8 05	7 57	8 09	7 53	8 13	7 50	8 16
55 00	8 16	7 49	8 12	7 53	8 08	7 57	8 04	8 01	8 00	8 05	7 57	8 08
60 00	8 22	7 42	8 18	7 46	8 14	7 50	8 10	7 54	8 06	7 58	8 03	8 01
65 00	8 29	7 35	8 25	7 39	8 21	7 43	8 17	7 47	8 13	7 51	8 10	7 54
70 00	8 34	7 29	8 30	7 33	8 26	7 37	8 22	7 41	8 18	7 45	8 15	7 48
75 00	8 38	7 24	8 34	7 28	8 30	7 32	8 26	7 36	8 22	7 40	8 19	7 43
80 00	8 44	7 18	8 40	7 22	8 36	7 26	8 32	7 30	8 28	7 34	8 25	7 37
85 00	8 48	7 13	8 44	7 17	8 40	7 21	8 36	7 25	8 32	7 29	8 29	7 32
90 00	8 52	7 08	8 48	7 12	8 44	7 16	8 40	7 20	8 36	7 24	8 33	7 27

ADDITIONAL CORR. FOR SUN'S ALT.	Day of Month.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
		″	″	″	″	″	″	″	″	″	″	″	″
	1st to 15th....	+18	+15	+8	0	− 8	−13	−14	−11	−5	+3	+11	+16
	16th to 31st...	+17	+12	+4	−4	−11	−14	−13	− 9	−1	+7	+14	+18

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* The corrections for the observed altitude of a Star or Planet involves the dip and the refraction; and for the observed altitude of the Sun's lower limb, the dip, refraction, parallax, and mean semidiameter, which is taken as 16′. A supplementary correction taking account of the variation of the Sun's semidiameter in the different months of the year is given at the foot of the main table.

TABLE 46.

Corrections* to be Applied to the Observed Altitude of a Star or of the Sun's Lower Limb, to Find the True Altitude—Continued.

Obs. Alt.	HEIGHT OF THE EYE.											
	59 Feet.		60 Feet.		61 Feet.		62 Feet.		63 Feet.		64 Feet.	
	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)
° ′	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″
6 30	0 44	15 25	0 40	15 29	0 36	15 33	0 32	15 37	0 29	15 40	0 25	15 44
40	0 54	15 15	0 50	15 19	0 46	15 23	0 42	15 27	0 39	15 30	0 35	15 34
50	1 04	15 05	1 00	15 09	0 56	15 13	0 52	15 17	0 49	15 20	0 45	15 24
7 00	1 14	14 55	1 10	14 59	1 06	15 03	1 02	15 07	0 59	15 10	0 55	15 14
10	1 23	14 46	1 19	14 50	1 15	14 54	1 11	14 58	1 08	15 01	1 04	15 05
20	1 32	14 37	1 28	14 41	1 24	14 45	1 20	14 49	1 17	14 52	1 13	14 56
7 30	1 41	14 28	1 37	14 32	1 33	14 36	1 29	14 40	1 26	14 43	1 22	14 47
40	1 49	14 20	1 45	14 24	1 41	14 28	1 37	14 32	1 34	14 35	1 30	14 39
50	1 57	14 12	1 53	14 16	1 49	14 20	1 45	14 24	1 42	14 27	1 38	14 31
8 00	2 05	14 04	2 01	14 08	1 57	14 12	1 53	14 16	1 50	14 19	1 46	14 23
10	2 12	13 57	2 08	14 01	2 04	14 05	2 00	14 09	1 57	14 12	1 53	14 16
20	2 19	13 50	2 15	13 54	2 11	13 58	2 07	14 02	2 04	14 05	2 00	14 09
8 30	2 26	13 43	2 22	13 47	2 18	13 51	2 14	13 55	2 11	13 58	2 07	14 02
40	2 33	13 36	2 29	13 40	2 25	13 44	2 21	13 48	2 18	13 51	2 14	13 55
50	2 39	13 30	2 35	13 34	2 31	13 38	2 27	13 42	2 24	13 45	2 20	13 49
9 00	2 45	13 24	2 41	13 28	2 37	13 32	2 33	13 36	2 30	13 39	2 26	13 43
20	2 57	13 12	2 53	13 16	2 49	13 20	2 45	13 24	2 42	13 27	2 38	13 31
40	3 08	13 01	3 04	13 05	3 00	13 09	2 56	13 13	2 53	13 16	2 49	13 20
10 00	3 19	12 50	3 15	12 54	3 11	12 58	3 07	13 02	3 04	13 05	3 00	13 09
20	3 29	12 40	3 25	12 44	3 21	12 48	3 17	12 52	3 14	12 55	3 10	12 59
40	3 38	12 31	3 34	12 35	3 30	12 39	3 26	12 43	3 23	12 46	3 19	12 50
11 00	3 47	12 22	3 43	12 26	3 39	12 30	3 35	12 34	3 32	12 37	3 28	12 41
30	3 59	12 10	3 55	12 14	3 51	12 18	3 47	12 22	3 44	12 25	3 40	12 29
12 00	4 10	11 59	4 06	12 03	4 02	12 07	3 58	12 11	3 55	12 14	3 51	12 18
30	4 21	11 48	4 17	11 52	4 13	11 56	4 09	12 00	4 06	12 03	4 02	12 07
13 00	4 31	11 38	4 27	11 42	4 23	11 46	4 19	11 50	4 16	11 53	4 12	11 57
30	4 40	11 29	4 36	11 33	4 32	11 37	4 28	11 41	4 25	11 44	4 21	11 48
14 00	4 48	11 21	4 44	11 25	4 40	11 29	4 36	11 33	4 33	11 36	4 29	11 40
15 00	5 04	11 05	5 00	11 09	4 56	11 13	4 52	11 17	4 49	11 20	4 45	11 24
16 00	5 17	10 52	5 13	10 56	5 09	11 00	5 05	11 04	5 02	11 07	4 58	11 11
17 00	5 30	10 39	5 26	10 43	5 22	10 47	5 18	10 51	5 15	10 54	5 11	10 58
18 00	5 40	10 29	5 36	10 33	5 32	10 37	5 28	10 41	5 25	10 44	5 21	10 48
19 00	5 50	10 19	5 46	10 23	5 42	10 27	5 38	10 31	5 35	10 34	5 31	10 38
20 00	5 58	10 10	5 54	10 14	5 50	10 18	5 46	10 22	5 43	10 25	5 39	10 29
22 00	6 14	9 54	6 10	9 58	6 06	10 02	6 02	10 06	5 59	10 09	5 55	10 13
24 00	6 27	9 41	6 23	9 45	6 19	9 49	6 15	9 53	6 12	9 56	6 08	10 00
26 00	6 38	9 30	6 34	9 34	6 30	9 38	6 26	9 42	6 23	9 45	6 19	9 49
28 00	6 48	9 20	6 44	9 24	6 40	9 28	6 36	9 32	6 33	9 35	6 29	9 39
30 00	6 56	9 12	6 52	9 16	6 48	9 20	6 44	9 24	6 41	9 27	6 37	9 31
32 00	7 04	9 04	7 00	9 08	6 56	9 12	6 52	9 16	6 49	9 19	6 45	9 23
34 00	7 11	8 57	7 07	9 01	7 03	9 05	6 59	9 09	6 56	9 12	6 52	9 16
36 00	7 17	8 51	7 13	8 55	7 09	8 59	7 05	9 03	7 02	9 06	6 58	9 10
38 00	7 22	8 46	7 18	8 50	7 14	8 54	7 10	8 58	7 07	9 01	7 03	9 05
40 00	7 27	8 40	7 23	8 44	7 19	8 48	7 15	8 52	7 12	8 55	7 08	8 59
45 00	7 38	8 29	7 34	8 33	7 30	8 37	7 26	8 41	7 23	8 44	7 19	8 48
50 00	7 46	8 20	7 42	8 24	7 38	8 28	7 34	8 32	7 31	8 35	7 27	8 39
55 00	7 53	8 12	7 49	8 16	7 45	8 20	7 41	8 24	7 38	8 27	7 34	8 31
60 00	7 59	8 05	7 55	8 09	7 51	8 13	7 47	8 17	7 44	8 20	7 40	8 24
65 00	8 06	7 58	8 02	8 02	7 58	8 06	7 54	8 10	7 51	8 13	7 47	8 17
70 00	8 11	7 52	8 07	7 56	8 03	8 00	7 59	8 04	7 56	8 07	7 52	8 11
75 00	8 15	7 47	8 11	7 51	8 07	7 55	8 03	7 59	8 00	8 02	7 56	8 06
80 00	8 21	7 41	8 17	7 45	8 13	7 49	8 09	7 53	8 06	7 56	8 02	8 00
85 00	8 25	7 36	8 21	7 40	8 17	7 44	8 13	7 48	8 10	7 51	8 06	7 55
90 00	8 29	7 31	8 25	7 35	8 21	7 39	8 17	7 43	8 14	7 46	8 10	7 50

	Day of Month.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
ADDITIONAL CORR. FOR SUN'S ALT.		″	″	″	″	″	″	″	″	″	″	″	″
	1st to 15th....	+18	+15	+8	0	− 8	−13	−14	−11	−5	+3	+11	+16
	16th to 31st...	+17	+12	+4	−4	−11	−14	−13	− 9	−1	+7	+14	+18

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* The corrections for the observed altitude of a Star or Planet involves the dip and the refraction; and for the observed altitude of the Sun's lower limb, the dip, refraction, parallax, and mean semidiameter, which is taken as 16′. A supplementary correction taking account of the variation of the Sun's semidiameter in the different months of the year is given at the foot of the main table.

TABLE 46.

Corrections* to be Applied to the Observed Altitude of a Star or of the Sun's Lower Limb, to Find the True Altitude—Continued.

Obs. Alt.	HEIGHT OF THE EYE.											
	65 Feet.		66 Feet.		67 Feet.		68 Feet.		69 Feet.		70 Feet.	
	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr. (+)	* Star's Corr. (−)
° ′	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″
6 30	0 21	15 48	0 18	15 51	0 14	15 55	0 10	15 59	0 07	16 02	0 03	16 06
40	0 31	15 38	0 28	15 41	0 24	15 45	0 20	15 49	0 17	15 52	0 13	15 56
50	0 41	15 28	0 38	15 31	0 34	15 35	0 30	15 39	0 27	15 42	0 23	15 46
7 00	0 51	15 18	0 48	15 21	0 44	15 25	0 40	15 29	0 37	15 32	0 33	15 36
10	1 00	15 09	0 57	15 12	0 53	15 16	0 49	15 20	0 46	15 23	0 42	15 27
20	1 09	15 00	1 06	15 03	1 02	15 07	0 58	15 11	0 55	15 14	0 51	15 18
7 30	1 18	14 51	1 15	14 54	1 11	14 58	1 07	15 02	1 04	15 05	1 00	15 09
40	1 26	14 43	1 23	14 46	1 19	14 50	1 15	14 54	1 12	14 57	1 08	15 01
50	1 34	14 35	1 31	14 38	1 27	14 42	1 23	14 46	1 20	14 49	1 16	14 53
8 00	1 42	14 27	1 39	14 30	1 35	14 34	1 31	14 38	1 28	14 41	1 24	14 45
10	1 49	14 20	1 46	14 23	1 42	14 27	1 38	14 31	1 35	14 34	1 31	14 38
20	1 56	14 13	1 53	14 16	1 49	14 20	1 45	14 24	1 42	14 27	1 38	14 31
8 30	2 03	14 06	2 00	14 09	1 56	14 13	1 52	14 17	1 49	14 20	1 45	14 24
40	2 10	13 59	2 07	14 02	2 03	14 06	1 59	14 10	1 56	14 13	1 52	14 17
50	2 16	13 53	2 13	13 56	2 09	14 00	2 05	14 04	2 02	14 07	1 58	14 11
9 00	2 22	13 47	2 19	13 50	2 15	13 54	2 11	13 58	2 08	14 01	2 04	14 05
20	2 34	13 35	2 31	13 38	2 27	13 42	2 23	13 46	2 20	13 49	2 16	13 53
40	2 45	13 24	2 42	13 27	2 38	13 31	2 34	13 35	2 31	13 38	2 27	13 42
10 00	2 56	13 13	2 53	13 16	2 49	13 20	2 45	13 24	2 42	13 27	2 38	13 31
20	3 06	13 03	3 03	13 06	2 59	13 10	2 55	13 14	2 52	13 17	2 48	13 21
40	3 15	12 54	3 12	12 57	3 08	13 01	3 04	13 05	3 01	13 08	2 57	13 12
11 00	3 24	12 45	3 21	12 48	3 17	12 52	3 13	12 56	3 10	12 59	3 06	13 03
30	3 36	12 33	3 33	12 36	3 29	12 40	3 25	12 44	3 22	12 47	3 18	12 51
12 00	3 47	12 22	3 44	12 25	3 40	12 29	3 36	12 33	3 33	12 36	3 29	12 40
30	3 58	12 11	3 55	12 14	3 51	12 18	3 47	12 22	3 44	12 25	3 40	12 29
13 00	4 08	12 01	4 05	12 04	4 01	12 08	3 57	12 12	3 54	12 15	3 50	12 19
30	4 17	11 52	4 14	11 55	4 10	11 59	4 06	12 03	4 03	12 06	3 59	12 10
14 00	4 25	11 44	4 22	11 47	4 18	11 51	4 14	11 55	4 11	11 58	4 07	12 02
15 00	4 41	11 28	4 38	11 31	4 34	11 35	4 30	11 39	4 27	11 42	4 23	11 46
16 00	4 54	11 15	4 51	11 18	4 47	11 22	4 43	11 26	4 40	11 29	4 36	11 33
17 00	5 07	11 02	5 04	11 05	5 00	11 09	4 56	11 13	4 53	11 16	4 49	11 20
18 00	5 17	10 52	5 14	10 55	5 10	10 59	5 06	11 03	5 03	11 06	4 59	11 10
19 00	5 27	10 42	5 24	10 45	5 20	10 49	5 16	10 53	5 13	10 56	5 09	11 00
20 00	5 35	10 33	5 32	10 36	5 28	10 40	5 24	10 44	5 21	10 47	5 17	10 51
22 00	5 51	10 17	5 48	10 20	5 44	10 24	5 40	10 28	5 37	10 31	5 33	10 35
24 00	6 04	10 04	6 01	10 07	5 57	10 11	5 53	10 15	5 50	10 18	5 46	10 22
26 00	6 15	9 53	6 12	9 56	6 08	10 00	6 04	10 04	6 01	10 07	5 57	10 11
28 00	6 25	9 43	6 22	9 46	6 18	9 50	6 14	9 54	6 11	9 57	6 07	10 01
30 00	6 33	9 35	6 30	9 38	6 26	9 42	6 22	9 46	6 19	9 49	6 15	9 53
32 00	6 41	9 27	6 38	9 30	6 34	9 34	6 30	9 38	6 27	9 41	6 23	9 45
34 00	6 48	9 20	6 45	9 23	6 41	9 27	6 37	9 31	6 34	9 34	6 30	9 38
36 00	6 54	9 14	6 51	9 17	6 47	9 21	6 43	9 25	6 40	9 28	6 36	9 32
38 00	6 59	9 09	6 56	9 12	6 52	9 16	6 48	9 20	6 45	9 23	6 41	9 27
40 00	7 04	9 03	7 01	9 06	6 57	9 10	6 53	9 14	6 50	9 17	6 46	9 21
45 00	7 15	8 52	7 12	8 55	7 08	8 59	7 04	9 03	7 01	9 06	6 57	9 10
50 00	7 23	8 43	7 20	8 46	7 16	8 50	7 12	8 54	7 09	8 57	7 05	9 01
55 00	7 30	8 35	7 27	8 38	7 23	8 42	7 19	8 46	7 16	8 49	7 12	8 53
60 00	7 36	8 28	7 33	8 31	7 29	8 35	7 25	8 39	7 22	8 42	7 18	8 46
65 00	7 43	8 21	7 40	8 24	7 36	8 28	7 32	8 32	7 29	8 35	7 25	8 39
70 00	7 48	8 15	7 45	8 18	7 41	8 22	7 37	8 26	7 34	8 29	7 30	8 33
75 00	7 52	8 10	7 49	8 13	7 45	8 17	7 41	8 21	7 38	8 24	7 34	8 28
80 00	7 58	8 04	7 55	8 07	7 51	8 11	7 47	8 15	7 44	8 18	7 40	8 22
85 00	8 02	7 59	7 59	8 02	7 55	8 06	7 51	8 10	7 48	8 13	7 44	8 17
90 00	8 06	7 54	8 03	7 57	7 59	8 01	7 55	8 05	7 52	8 08	7 48	8 12

	Day of Month.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
ADDITIONAL CORR. FOR SUN'S ALT.		″	″	″	″	″	″	″	″	″	″	″	″
	1st to 15th....	+18	+15	+8	0	− 8	−13	−14	−11	−5	+3	+11	+16
	16th to 31st...	+17	+12	+4	−4	−11	−14	−13	− 9	−1	+7	+14	+18

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* The corrections for the observed altitude of a Star or Planet involves the dip and the refraction; and for the observed altitude of the Sun's lower limb, the dip, refraction, parallax, and mean semidiameter, which is taken as 16′. A supplementary correction taking account of the variation of the Sun's semidiameter in the different months of the year is given at the foot of the main table.

TABLE 46.

Corrections* to be Applied to the Observed Altitude of a Star or of the Sun's Lower Limb, to Find the True Altitude—Continued.

Obs. Alt.	HEIGHT OF THE EYE.											
	71 Feet.		72 Feet.		73 Feet.		74 Feet.		75 Feet.		76 Feet.	
	⊙ Sun's Corr. (+)	* Star's Corr. (−)	⊙ Sun's Corr.	* Star's Corr. (−)	⊙ Sun's Corr.	* Star's Corr. (−)	⊙ Sun's Corr.	* Star's Corr. (−)	⊙ Sun's Corr.	* Star's Corr. (−)	⊙ Sun's Corr.	* Star's Corr. (−)
° ′	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″
6 30	0 00	16 09	−0 04	16 13	−0 08	16 17	−0 11	16 20	−0 14	16 23	−0 17	16 26
40	0 10	15 59	+0 06	16 03	+0 02	16 07	−0 01	16 10	−0 04	16 13	−0 07	16 16
50	0 20	15 49	0 16	15 53	0 12	15 57	+0 09	16 00	+0 06	16 03	+0 03	16 06
7 00	0 30	15 39	0 26	15 43	0 22	15 47	1 19	15 50	0 16	15 53	0 13	15 56
10	0 39	15 30	0 35	15 34	0 31	15 38	1 28	15 41	0 25	15 44	0 22	15 47
20	0 48	15 21	0 44	15 25	0 40	15 29	1 37	15 32	0 34	15 35	0 31	15 38
7 30	0 57	15 12	0 53	15 16	0 49	15 20	1 46	15 23	0 43	15 26	0 40	15 29
40	1 05	15 04	1 01	15 08	0 57	15 12	1 54	15 15	0 51	15 18	0 48	15 21
50	1 13	14 56	1 09	15 00	1 05	15 04	1 02	15 07	0 59	15 10	0 56	15 13
8 00	1 21	14 48	1 17	14 52	1 13	14 56	1 10	14 59	1 07	15 02	1 04	15 05
10	1 28	14 41	1 24	14 45	1 20	14 49	1 17	14 52	1 14	14 55	1 11	14 58
20	1 35	14 34	1 31	14 38	1 27	14 42	1 24	14 45	1 21	14 48	1 18	14 51
8 30	1 42	14 27	1 38	14 31	1 34	14 35	1 31	14 38	1 28	14 41	1 25	14 44
40	1 49	14 20	1 45	14 24	1 41	14 28	1 38	14 31	1 35	14 34	1 32	14 37
50	1 55	14 14	1 51	14 18	1 47	14 22	1 44	14 25	1 41	14 28	1 38	14 31
9 00	2 01	14 08	1 57	14 12	1 53	14 16	1 50	14 19	1 47	14 22	1 44	14 25
20	2 13	13 56	2 09	14 00	2 05	14 04	2 02	14 07	1 59	14 10	1 56	14 13
40	2 24	13 45	2 20	13 49	2 16	13 53	2 13	13 56	2 10	13 59	2 07	14 02
10 00	2 35	13 34	2 31	13 38	2 27	13 42	2 24	13 45	2 21	13 48	2 18	13 51
20	2 45	13 24	2 41	13 28	2 37	13 32	2 34	13 35	2 31	13 38	2 28	13 41
40	2 54	13 15	2 50	13 19	2 46	13 23	2 43	13 26	2 40	13 29	2 37	13 32
11 00	3 03	13 06	2 59	13 10	2 55	13 14	2 52	13 17	2 49	13 20	2 46	13 23
30	3 15	12 54	3 11	12 58	3 07	13 02	3 04	13 05	3 01	13 08	2 58	13 11
12 00	3 26	12 43	3 22	12 47	3 18	12 51	3 15	12 54	3 12	12 57	3 09	13 00
30	3 37	12 32	3 33	12 36	3 29	12 40	3 26	12 43	3 23	12 46	3 20	12 49
13 00	3 47	12 22	3 43	12 26	3 39	12 30	3 36	12 33	3 33	12 36	3 30	12 39
30	3 56	12 13	3 52	12 17	3 48	12 21	3 45	12 24	3 42	12 27	3 39	12 30
14 00	4 04	12 05	4 00	12 09	3 56	12 13	3 53	12 16	3 50	12 19	3 47	12 22
15 00	4 20	11 49	4 16	11 53	4 12	11 57	4 09	12 00	4 06	12 03	4 03	12 06
16 00	4 33	11 36	4 29	11 40	4 25	11 44	4 22	11 47	4 19	11 50	4 16	11 53
17 00	4 46	11 23	4 42	11 27	4 38	11 31	4 35	11 34	4 32	11 37	4 29	11 40
18 00	4 56	11 13	4 52	11 17	4 48	11 21	4 45	11 24	4 42	11 27	4 39	11 30
19 00	5 06	11 03	5 02	11 07	4 58	11 11	4 55	11 14	4 52	11 17	4 49	11 20
20 00	5 14	10 54	5 10	10 58	5 06	11 02	5 03	11 05	5 00	11 08	4 57	11 11
22 00	5 30	10 38	5 26	10 42	5 22	10 46	5 19	10 49	5 16	10 52	5 13	10 55
24 00	5 43	10 25	5 39	10 29	5 35	10 33	5 32	10 36	5 29	10 39	5 26	10 42
26 00	5 54	10 14	5 50	10 18	5 46	10 22	5 43	10 25	5 40	10 28	5 37	10 31
28 00	6 04	10 04	6 00	10 08	5 56	10 12	5 53	10 15	5 50	10 18	5 47	10 21
30 00	6 12	9 56	6 08	10 00	6 04	10 04	6 01	10 07	5 58	10 10	5 55	10 13
32 00	6 20	9 48	6 16	9 52	6 12	9 56	6 09	9 59	6 06	10 02	6 03	10 05
34 00	6 27	9 41	6 23	9 45	6 19	9 49	6 16	9 52	6 13	9 55	6 10	9 58
36 00	6 33	9 35	6 29	9 39	6 25	9 43	6 22	9 46	6 19	9 49	6 16	9 52
38 00	6 38	9 30	6 34	9 34	6 30	9 38	6 27	9 41	6 24	9 44	6 21	9 47
40 00	6 43	9 24	6 39	9 28	6 35	9 32	6 32	9 35	6 29	9 38	6 26	9 41
45 00	6 54	9 13	6 50	9 17	6 46	9 21	6 43	9 24	6 40	9 27	6 37	9 30
50 00	7 02	9 04	6 58	9 08	6 54	9 12	6 51	9 15	6 48	9 18	6 45	9 21
55 00	7 09	8 56	7 05	9 00	7 01	9 04	6 58	9 07	6 55	9 10	6 52	9 13
60 00	7 15	8 49	7 11	8 53	7 07	8 57	7 04	9 00	7 01	9 03	6 58	9 06
65 00	7 22	8 42	7 18	8 46	7 14	8 50	7 11	8 53	7 08	8 56	7 05	8 59
70 00	7 27	8 36	7 23	8 40	7 19	8 44	7 16	8 47	7 13	8 50	7 10	8 53
75 00	7 31	8 31	7 27	8 35	7 23	8 39	7 20	8 42	7 17	8 45	7 14	8 48
80 00	7 37	8 25	7 33	8 29	7 29	8 33	7 26	8 36	7 23	8 39	7 20	8 42
85 00	7 41	8 20	7 37	8 24	7 33	8 28	7 30	8 31	7 27	8 34	7 24	8 37
90 00	7 45	8 15	+7 41	8 19	+7 37	8 23	+7 34	8 26	+7 31	8 29	+7 28	8 32

Additional Corr. for Sun's Alt.	Day of Month.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
		″	″	″	″	″	″	″	″	″	″	″	″
	1st to 15th....	+18	+15	+8	0	− 8	−13	−14	−11	−5	+3	+11	+16
	16th to 31st...	+17	+12	+4	−4	−11	−14	−13	− 9	−1	+7	+14	+18

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* The corrections for the observed altitude of a Star or Planet involves the dip and the refraction; and for the observed altitude of the Sun's lower limb, the dip, refraction, parallax, and mean semidiameter, which is taken as 16′. A supplementary correction taking account of the variation of the Sun's semidiameter in the different months of the year is given at the foot of the main table.

TABLE 46.

Corrections* to be Applied to the Observed Altitude of a Star or of the Sun's Lower Limb, to Find the True Altitude—Continued.

Obs. Alt.	HEIGHT OF THE EYE.											
	77 Feet.		78 Feet.		79 Feet.		80 Feet.		81 Feet.		82 Feet.	
	⊙ Sun's Corr.	* Star's Corr. (−)	⊙ Sun's Corr.	* Star's Corr. (−)	⊙ Sun's Corr.	* Star's Corr. (−)	⊙ Sun's Corr.	* Star's Corr. (−)	⊙ Sun's Corr.	* Star's Corr. (−)	⊙ Sun's Corr.	* Star's Corr. (−)
° ′	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″
6 30	−0 21	16 30	−0 24	16 33	−0 28	16 37	−0 31	16 40	−0 34	16 43	−0 37	16 46
40	−0 11	16 20	−0 14	16 23	−0 18	16 27	−0 21	16 30	−0 24	16 33	−0 27	16 36
50	−0 01	16 10	−0 04	16 13	−0 08	16 17	−0 11	16 20	−0 14	16 23	−0 17	16 26
7 00	+0 09	16 00	+0 06	16 03	+0 02	16 07	−0 01	16 10	−0 04	16 13	−0 07	16 16
10	0 18	15 51	0 15	15 54	0 11	15 58	+0 08	16 01	+0 05	16 04	+0 02	16 07
20	0 27	15 42	0 24	15 45	0 20	15 49	0 17	15 52	0 14	15 55	0 11	15 58
7 30	0 36	15 33	0 33	15 36	0 29	15 40	0 26	15 43	0 23	15 46	0 20	15 49
40	0 44	15 25	0 41	15 28	0 37	15 32	0 34	15 35	0 31	15 38	0 28	15 41
50	0 52	15 17	0 49	15 20	0 45	15 24	0 42	15 27	0 39	15 30	0 36	15 33
8 00	1 00	15 09	0 57	15 12	0 53	15 16	0 50	15 19	0 47	15 22	0 44	15 25
10	1 07	15 02	1 04	15 05	1 00	15 09	0 57	15 12	0 54	15 15	0 51	15 18
20	1 14	14 55	1 11	14 58	1 07	15 02	1 04	15 05	1 01	15 08	0 58	15 11
8 30	1 21	14 48	1 18	14 51	1 14	14 55	1 11	14 58	1 08	15 01	1 05	15 04
40	1 28	14 41	1 25	14 44	1 21	14 48	1 18	14 51	1 15	14 54	1 12	14 57
50	1 34	14 35	1 31	14 38	1 27	14 42	1 24	14 45	1 21	14 48	1 18	14 51
9 00	1 40	14 29	1 37	14 32	1 33	14 36	1 30	14 39	1 27	14 42	1 24	14 45
20	1 52	14 17	1 49	14 20	1 45	14 24	1 42	14 27	1 39	14 30	1 36	14 33
40	2 03	14 06	2 00	14 09	1 56	14 13	1 53	14 16	1 50	14 19	1 47	14 22
10 00	2 14	13 55	2 11	13 58	2 07	14 02	2 04	14 05	2 01	14 08	1 58	14 11
20	2 24	13 45	2 21	13 48	2 17	13 52	2 14	13 55	2 11	13 58	2 08	14 01
40	2 33	13 36	2 30	13 39	2 26	13 43	2 23	13 46	2 20	13 49	2 17	13 52
11 00	2 42	13 27	2 39	13 30	2 35	13 34	2 32	13 37	2 29	13 40	2 26	13 43
30	2 54	13 15	2 51	13 18	2 47	13 22	2 44	13 25	2 41	13 28	2 38	13 31
12 00	3 05	13 04	3 02	13 07	2 58	13 11	2 55	13 14	2 52	13 17	2 49	13 20
30	3 16	12 53	3 13	12 56	3 09	13 00	3 06	13 03	3 03	13 06	3 00	13 09
13 00	3 26	12 43	3 23	12 46	3 19	12 50	3 16	12 53	3 13	12 56	3 10	12 59
30	3 35	12 34	3 32	12 37	3 28	12 41	3 25	12 44	3 22	12 47	3 19	12 50
14 00	3 43	12 26	3 40	12 29	3 36	12 33	3 33	12 36	3 30	12 39	3 27	12 42
15 00	3 59	12 10	3 56	12 13	3 52	12 17	3 49	12 20	3 46	12 23	3 43	12 26
16 00	4 12	11 57	4 09	12 00	4 05	12 04	4 02	12 07	3 59	12 10	3 56	12 13
17 00	4 25	11 44	4 22	11 47	4 18	11 51	4 15	11 54	4 12	11 57	4 09	12 00
18 00	4 35	11 34	4 32	11 37	4 28	11 41	4 25	11 44	4 22	11 47	4 19	11 50
19 00	4 45	11 24	4 42	11 27	4 38	11 31	4 35	11 34	4 32	11 37	4 29	11 40
20 00	4 53	11 15	4 50	11 18	4 46	11 22	4 43	11 25	4 40	11 28	4 37	11 31
22 00	5 09	10 59	5 06	11 02	5 02	11 06	4 59	11 09	4 56	11 12	4 53	11 15
24 00	5 22	10 46	5 19	10 49	5 15	10 53	5 12	10 56	5 09	10 59	5 06	11 02
26 00	5 33	10 35	5 30	10 38	5 26	10 42	5 23	10 45	5 20	10 48	5 17	10 51
28 00	5 43	10 25	5 40	10 28	5 36	10 32	5 33	10 35	5 30	10 38	5 27	10 41
30 00	5 51	10 17	5 48	10 20	5 44	10 24	5 41	10 27	5 38	10 30	5 35	10 33
32 00	5 59	10 09	5 56	10 12	5 52	10 16	5 49	10 19	5 46	10 22	5 43	10 25
34 00	6 06	10 02	6 03	10 05	5 59	10 09	5 56	10 12	5 53	10 15	5 50	10 18
36 00	6 12	9 56	6 09	9 59	6 05	10 03	6 02	10 06	5 59	10 09	5 56	10 12
38 00	6 17	9 51	6 14	9 54	6 10	9 58	6 07	10 01	6 04	10 04	6 01	10 07
40 00	6 22	9 45	6 19	9 48	6 15	9 52	6 12	9 55	6 09	9 58	6 06	10 01
45 00	6 33	9 34	6 30	9 37	6 26	9 41	6 23	9 44	6 20	9 47	6 17	9 50
50 00	6 41	9 25	6 38	9 28	6 34	9 32	6 31	9 35	6 28	9 38	6 25	9 41
55 00	6 48	9 17	6 45	9 20	6 41	9 24	6 38	9 27	6 35	9 30	6 32	9 33
60 00	6 54	9 10	6 51	9 13	6 47	9 17	6 44	9 20	6 41	9 23	6 38	9 26
65 00	7 01	9 03	6 58	9 06	6 54	9 10	6 51	9 13	6 48	9 16	6 45	9 19
70 00	7 06	8 57	7 03	9 00	6 59	9 04	6 56	9 07	6 53	9 10	6 50	9 13
75 00	7 10	8 52	7 07	8 55	7 03	8 59	7 00	9 02	6 57	9 05	6 54	9 08
80 00	7 16	8 46	7 13	8 49	7 09	8 53	7 06	8 56	7 03	8 59	7 00	9 02
85 00	7 20	8 41	7 17	8 44	7 13	8 48	7 10	8 51	7 07	8 54	7 04	8 57
90 00	+7 24	8 36	+7 21	8 39	+7 17	8 43	+7 14	8 46	+7 11	8 49	+7 08	8 52

Additional Corr. for Sun's Alt.	Day of Month.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
		″	″	″	″	″	″	″	″	″	″	″	″
	1st to 15th....	+18	+15	+8	0	− 8	−13	−14	−11	−5	+3	+11	+16
	16th to 31st...	+17	+12	+4	−4	−11	−14	−13	− 9	−1	+7	+14	+18

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* The corrections for the observed altitude of a Star or Planet involves the dip and the refraction; and for the observed altitude of the Sun's lower limb, the dip, refraction, parallax, and mean semidiameter, which is taken as 16′. A supplementary correction taking account of the variation of the Sun's semidiameter in the different months of the year is given at the foot of the main table.

TABLE 46.

Corrections* to be Applied to the Observed Altitude of a Star or of the Sun's Lower Limb, to Find the True Altitude—Continued.

Obs. Alt.	HEIGHT OF THE EYE.											
	89 Feet.		90 Feet.		91 Feet.		92 Feet.		93 Feet.		94 Feet.	
	⊙ Sun's Corr.	* Star's Corr. (−)	⊙ Sun's Corr.	* Star's Corr. (−)	⊙ Sun's Corr.	* Star's Corr. (−)	⊙ Sun's Corr.	* Star's Corr. (−)	⊙ Sun's Corr.	* Star's Corr. (−)	⊙ Sun's Corr.	* Star's Corr. (−)
° ′	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″
6 30	−1 00	17 09	−1 03	17 12	−1 06	17 15	−1 09	17 18	−1 12	17 21	−1 15	17 24
40	−0 50	16 59	−0 53	17 02	−0 56	17 05	−0 59	17 08	−1 02	17 11	−1 05	17 14
50	−0 40	16 49	−0 43	16 52	−0 46	16 55	−0 49	16 58	−0 52	17 01	−0 55	17 04
7 00	−0 30	16 39	−0 33	16 42	−0 36	16 45	−0 39	16 48	−0 42	16 51	−0 45	16 54
10	−0 21	16 30	−0 24	16 33	−0 27	16 36	−0 30	16 39	−0 33	16 42	−0 36	16 45
20	−0 12	16 21	−0 15	16 24	−0 18	16 27	−0 21	16 30	−0 24	16 33	−0 27	16 36
7 30	−0 03	16 12	−0 06	16 15	−0 09	16 18	−0 12	16 21	−0 15	16 24	−0 18	16 27
40	+0 05	16 04	+0 02	16 07	−0 01	16 10	−0 04	16 13	−0 07	16 16	−0 10	16 19
50	0 13	15 56	0 10	15 59	+0 07	16 02	+0 04	16 05	+0 01	16 08	−0 02	16 11
8 00	0 21	15 48	0 18	15 51	0 15	15 54	0 12	15 57	0 09	16 00	+0 06	16 03
10	0 28	15 41	0 25	15 44	0 22	15 47	0 19	15 50	0 16	15 53	0 13	15 56
20	0 35	15 34	0 32	15 37	0 29	15 40	0 26	15 43	0 23	15 46	0 20	15 49
8 30	0 42	15 27	0 39	15 30	0 36	15 33	0 33	15 36	0 30	15 39	0 27	15 42
40	0 49	15 20	0 46	15 23	0 43	15 26	0 40	15 29	0 37	15 32	0 34	15 35
50	0 55	15 14	0 52	15 17	0 49	15 20	0 46	15 23	0 43	15 26	0 40	15 29
9 00	1 01	15 08	0 58	15 11	0 55	15 14	0 52	15 17	0 49	15 20	0 46	15 23
20	1 13	14 56	1 10	14 59	1 07	15 02	1 04	15 05	1 01	15 08	0 58	15 11
40	1 24	14 45	1 21	14 48	1 18	14 51	1 15	14 54	1 12	14 57	1 09	15 00
10 00	1 35	14 34	1 32	14 37	1 29	14 40	1 26	14 43	1 23	14 46	1 20	14 49
20	1 45	14 24	1 42	14 27	1 39	14 30	1 36	14 33	1 33	14 36	1 30	14 39
40	1 54	14 15	1 51	14 18	1 48	14 21	1 45	14 24	1 42	14 27	1 39	14 30
11 00	2 03	14 06	2 00	14 09	1 57	14 12	1 54	14 15	1 51	14 18	1 48	14 21
30	2 15	13 54	2 12	13 57	2 09	14 00	2 06	14 03	2 03	14 06	2 00	14 09
12 00	2 26	13 43	2 23	13 46	2 20	13 49	2 17	13 52	2 14	13 55	2 11	13 58
30	2 37	13 32	2 34	13 35	2 31	13 38	2 28	13 41	2 25	13 44	2 22	13 47
13 00	2 47	13 22	2 44	13 25	2 41	13 28	2 38	13 31	2 35	13 34	2 32	13 37
30	2 56	13 13	2 53	13 16	2 50	13 19	2 47	13 22	2 44	13 25	2 41	13 28
14 00	3 04	13 05	3 01	13 08	2 58	13 11	2 55	13 14	2 52	13 17	2 49	13 20
15 00	3 20	12 49	3 17	12 52	3 14	12 55	3 11	12 58	3 08	13 01	3 05	13 04
16 00	3 33	12 36	3 30	12 39	3 27	12 42	3 24	12 45	3 21	12 48	3 18	12 51
17 00	3 46	12 23	3 43	12 26	3 40	12 29	3 37	12 32	3 34	12 35	3 31	12 38
18 00	3 56	12 13	3 53	12 16	3 50	12 19	3 47	12 22	3 44	12 25	3 41	12 28
19 00	4 06	12 03	4 03	12 06	4 00	12 09	3 57	12 12	3 54	12 15	3 51	12 18
20 00	4 14	11 54	4 11	11 57	4 08	12 00	4 05	12 03	4 02	12 06	3 59	12 09
22 00	4 30	11 38	4 27	11 41	4 24	11 44	4 21	11 47	4 18	11 50	4 15	11 53
24 00	4 43	11 25	4 40	11 28	4 37	11 31	4 34	11 34	4 31	11 37	4 28	11 40
26 00	4 54	11 14	4 51	11 17	4 48	11 20	4 45	11 23	4 42	11 26	4 39	11 29
28 00	5 04	11 04	5 01	11 07	4 58	11 10	4 55	11 13	4 52	11 16	4 49	11 19
30 00	5 12	10 56	5 09	10 59	5 06	11 02	5 03	11 05	5 00	11 08	4 57	11 11
32 00	5 20	10 48	5 17	10 51	5 14	10 54	5 11	10 57	5 08	11 00	5 05	11 03
34 00	5 27	10 41	5 24	10 44	5 21	10 47	5 18	10 50	5 15	10 53	5 12	10 56
36 00	5 33	10 35	5 30	10 38	5 27	10 41	5 24	10 44	5 21	10 47	5 18	10 50
38 00	5 38	10 30	5 35	10 33	5 32	10 36	5 29	10 39	5 26	10 42	5 23	10 45
40 00	5 43	10 24	5 40	10 27	5 37	10 30	5 34	10 33	5 31	10 36	5 28	10 39
45 00	5 54	10 13	5 51	10 16	5 48	10 19	5 45	10 22	5 42	10 25	5 39	10 28
50 00	6 02	10 04	5 59	10 07	5 56	10 10	5 53	10 13	5 50	10 16	5 47	10 19
55 00	6 09	9 56	6 06	9 59	6 03	10 02	6 00	10 05	5 57	10 08	5 54	10 11
60 00	6 15	9 49	6 12	9 52	6 09	9 55	6 06	9 58	6 03	10 01	6 00	10 04
65 00	6 22	9 42	6 19	9 45	6 16	9 48	6 13	9 51	6 10	9 54	6 07	9 57
70 00	6 27	9 36	6 24	9 39	6 21	9 42	6 18	9 45	6 15	9 48	6 12	9 51
75 00	6 31	9 31	6 28	9 34	6 25	9 37	6 22	9 40	6 19	9 43	6 16	9 46
80 00	6 37	9 25	6 34	9 28	6 31	9 31	6 28	9 34	6 25	9 37	6 22	9 40
85 00	6 41	9 20	6 38	9 23	6 35	9 26	6 32	9 29	6 29	9 32	6 26	9 35
90 00	+6 45	9 15	+6 42	9 18	+6 39	9 21	+6 36	9 24	+6 33	9 27	+6 30	9 30

Additional Corr. for Sun's Alt.	Day of Month.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
		″	″	″	″	″	″	″	″	″	″	″	″
	1st to 15th....	+18	+15	+8	0	− 8	−13	−14	−11	−5	+3	+11	+16
	16th to 31st..	+17	+12	+4	−4	−11	−14	−13	− 9	−1	+7	+14	+18

* The corrections for the observed altitude of a Star or Planet involves the dip and the refraction; and for the observed altitude of the Sun's lower limb, the dip, refraction, parallax, and mean semidiameter, which is taken as 16′. A supplementary correction taking account of the variation of the Sun's semidiameter in the different months of the year is given at the foot of the main table.

TABLE 46.

Corrections* to be Applied to the Observed Altitude of a Star or o the True Altitude—Continued.

Obs. Alt.	HEIGHT OF THE EYE.							
	95 Feet.		96 Feet.		97 Feet.		98 Feet.	
	⊙ Sun's Corr.	* Star's Corr. (−)	⊙ Sun's Corr.	* Star's Corr. (−)	⊙ Sun's Corr.	* Star's Corr. (−)	⊙ Sun's Corr.	* Star Cor (−
° ′	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′
6 30	−1 18	17 27	−1 21	17 30	−1 24	17 33	−1 27	17
40	−1 08	17 17	−1 11	17 20	−1 14	17 23	−1 17	17
50	−0 58	17 07	−1 01	17 10	−1 04	17 13	−1 07	17
7 00	−0 48	16 57	−0 51	17 00	−0 54	17 03	−0 57	17
10	−0 39	16 48	−0 42	16 51	−0 45	16 54	−0 48	16
20	−0 30	16 39	−0 33	16 42	−0 36	16 45	−0 39	16
7 30	−0 21	16 30	−0 24	16 33	−0 27	16 36	−0 30	16
40	−0 13	16 22	−0 16	16 25	−0 19	16 28	−0 22	16
50	−0 05	16 14	−0 08	16 17	−0 11	16 20	−0 14	16
8 00	+0 03	16 06	0 00	16 09	−0 03	16 12	−0 06	16
10	0 10	15 59	+0 07	16 02	+0 04	16 05	+0 01	16
20	0 17	15 52	0 14	15 55	0 11	15 58	0 08	16
8 30	0 24	15 45	0 21	15 48	0 18	15 51	0 15	15
40	0 31	15 38	0 28	15 41	0 25	15 44	0 22	15
50	0 37	15 32	0 34	15 35	0 31	15 38	0 28	15
9 00	0 43	15 26	0 40	15 29	0 37	15 32	0 34	15
20	0 55	15 14	0 52	15 17	0 49	15 20	0 46	15
40	1 06	15 03	1 03	15 06	1 00	15 09	0 57	15
10 00	1 17	14 52	1 14	14 55	1 11	14 58	1 08	15
20	1 27	14 42	1 24	14 45	1 21	14 48	1 18	14
40	1 36	14 33	1 33	14 36	1 30	14 39	1 27	14
11 00	1 45	14 24	1 42	14 27	1 39	14 30	1 36	14
30	1 57	14 12	1 54	14 15	1 51	14 18	1 48	14
12 00	2 08	14 01	2 05	14 04	2 02	14 07	1 59	14
30	2 19	13 50	2 16	13 53	2 13	13 56	2 10	13
13 00	2 29	13 40	2 26	13 43	2 23	13 46	2 20	13
30	2 38	13 31	2 35	13 34	2 32	13 37	2 29	13
14 00	2 46	13 23	2 43	13 26	2 40	13 29	2 37	13
15 00	3 02	13 07	2 59	13 10	2 56	13 13	2 53	13
16 00	3 15	12 54	3 12	12 57	3 09	13 00	3 06	13
17 00	3 28	12 41	3 25	12 44	3 22	12 47	3 19	12
18 00	3 38	12 31	3 35	12 34	3 32	12 37	3 29	12
19 00	3 48	12 21	3 45	12 24	3 42	12 27	3 39	12
20 00	3 59	12 12	3 53	12 15	3 50	12 18	3 47	12
22 00	4 12	11 56	4 09	11 59	4 06	12 02	4 03	12
24 00	4 25	11 43	4 22	11 46	4 19	11 49	4 16	11
26 00	4 36	11 32	4 33	11 35	4 30	11 38	4 27	11
28 00	4 46	11 22	4 43	11 25	4 40	11 28	4 37	11
30 00	4 54	11 14	4 51	11 17	4 48	11 20	4 45	11
32 00	5 02	11 06	4 59	11 09	4 56	11 12	4 53	11
34 00	5 09	10 59	5 06	11 02	5 03	11 05	5 00	11
36 00	5 15	10 53	5 12	10 56	5 09	10 59	5 06	11
38 00	5 20	10 48	5 17	10 51	5 14	10 54	5 11	10
40 00	5 25	10 42	5 22	10 45	5 19	10 48	5 16	10
45 00	5 36	10 31	5 33	10 34	5 30	10 37	5 27	10
50 00	5 44	10 22	5 41	10 25	5 38	10 28	5 35	10
55 00	5 51	10 14	5 48	10 17	5 45	10 20	5 42	10
60 00	5 57	10 07	5 54	10 10	5 51	10 13	5 48	10
65 00	6 04	10 00	6 01	10 03	5 58	10 06	5 55	10
70 00	6 09	9 54	6 06	9 57	6 03	10 00	6 00	10
75 00	6 13	9 49	6 10	9 52	6 07	9 55	6 04	9
80 00	6 19	9 43	6 16	9 46	6 13	9 49	6 10	9
85 00	6 23	9 38	6 20	9 41	6 17	9 44	6 14	9
90 00	6 27	9 33	+6 24	9 36	+6 21	9 39	+6 18	9

ADDITIONAL CORR. FOR SUN'S ALT.	Day of Month.	Jan.	Feb.	Mar.	Apr.	May.	June.
		″	″	″	″	″	″
	1st to 15th....	+18	+15	+8	0	− 8	−13
	16th to 31st...	+17	+12	+4	−4	−11	−14

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* The corrections for the observed altitude of a Star or Planet involves the dip and
of the Sun's lower limb, the dip, refraction, parallax, and mean semidiameter, which i
taking account of the variation of the Sun's semidiameter in the different months of th

TABLE 47.

Longitude Factors.

F is the change in longitude due to a change of 1′ in latitude.

	Latitude.								
Bearing.	0°	1°	2°	4°	6°	8°	10°	12°	Bearing.
°	′	′	′	′	′	′	′	′	°
1	57.29	57.30	57.32	57.43	57.61	57.85	58.17	58.57	1
2	28.64	28.64	28.65	28.71	28.79	28.92	29.08	29.28	2
3	19.08	19.08	19.09	19.13	19.19	19.27	19.38	19.51	3
4	14.30	14.30	14.31	14.34	14.38	14.44	14.52	14.62	4
5	11.43	11.43	11.44	11.46	11.49	11.54	11.61	11.69	5
6	9.51	9.52	9.52	9.54	9.57	9.61	9.66	9.73	6
7	8.14	8.15	8.15	8.16	8.19	8.22	8.27	8.33	7
8	7.12	7.12	7.12	7.13	7.15	7.18	7.22	7.27	8
10	5.67	5.67	5.68	5.69	5.70	5.73	5.76	5.80	10
12	4.71	4.71	4.71	4.72	4.73	4.75	4.78	4.81	12
14	4.01	4.01	4.01	4.02	4.03	4.05	4.07	4.10	14
16	3.49	3.49	3.49	3.50	3.51	3.52	3.54	3.56	16
18	3.08	3.08	3.08	3.08	3.10	3.11	3.13	3.15	18
20	2.75	2.75	2.75	2.75	2.76	2.77	2.79	2.81	20
22	2.47	2.47	2.48	2.48	2.49	2.50	2.51	2.53	22
24	2.25	2.25	2.25	2.25	2.26	2.27	2.28	2.30	24
26	2.05	2.05	2.05	2.05	2.06	2.07	2.08	2.10	26
28	1.88	1.88	1.88	1.88	1.89	1.90	1.91	1.92	28
30	1.73	1.73	1.73	1.74	1.74	1.75	1.76	1.77	30
32	1.60	1.60	1.60	1.60	1.61	1.62	1.63	1.64	32
34	1.48	1.48	1.48	1.49	1.49	1.50	1.50	1.52	34
36	1.38	1.38	1.38	1.38	1.38	1.39	1.40	1.41	36
38	1.28	1.28	1.28	1.28	1.29	1.29	1.30	1.31	38
40	1.19	1.19	1.19	1.19	1.20	1.20	1.21	1.22	40
42	1.11	1.11	1.11	1.11	1.12	1.12	1.13	1.14	42
44	1.04	1.04	1.04	1.04	1.04	1.05	1.05	1.06	44
46	.97	.97	.97	.97	.97	.98	.98	.99	46
48	.90	.90	.90	.90	.90	.91	.91	.92	48
50	.84	.84	.84	.84	.84	.85	.85	.86	50
52	.78	.78	.78	.78	.79	.79	.79	.80	52
54	.73	.73	.73	.73	.73	.73	.74	.74	54
56	.67	.67	.67	.68	.68	.68	.68	.69	56
58	.63	.63	.63	.63	.63	.63	.63	.64	58
60	.58	.58	.58	.58	.58	.58	.59	.59	60
62	.53	.53	.53	.53	.53	.54	.54	.54	62
64	.49	.49	.49	.49	.49	.49	.50	.50	64
66	.45	.45	.45	.45	.45	.45	.45	.46	66
68	.40	.40	.40	.40	.40	.41	.41	.41	68
70	.36	.36	.36	.36	.37	.37	.37	.37	70
72	.33	.33	.33	.33	.33	.33	.33	.33	72
74	.29	.29	.29	.29	.29	.29	.29	.29	74
76	.25	.25	.25	.25	.25	.25	.25	.25	76
78	.21	.21	.21	.21	.21	.21	.22	.22	78
80	.18	.18	.18	.18	.18	.18	.18	.18	80
81	.16	.16	.16	.16	.16	.16	.16	.16	81
82	.14	.14	.14	.14	.14	.14	.14	.14	82
83	.12	.12	.12	.12	.12	.12	.12	.13	83
84	.10	.10	.10	.10	.10	.10	.11	.11	84
85	.09	.09	.09	.09	.09	.09	.09	.09	85
86	.07	.07	.07	.07	.07	.07	.07	.07	86
87	.05	.05	.05	.05	.05	.05	.05	.05	87
88	.03	.03	.03	.03	.03	.03	.03	.04	88
89	.02	.02	.02	.02	.02	.02	.02	.02	89
90	.00	.00	.00	.00	.00	.00	.00	.00	90
	0°	1°	2°	4°	6°	8°	10°	12°	

Corr. to Long. = Error in Lat. × F.

TABLE 47.

Longitude Factc

F is the change in longitude due to a ch

	Latitude.				
Bear-ing.	14°	16°	18°	20°	22°
°	′	′	′	′	′
1	59.04	59.60	60.24	60.97	61.
2	29.51	29.79	30.11	30.47	30.
3	19.67	19.85	20.06	20.31	20.
4	14.74	14.88	15.04	15.22	15.
5	11.78	11.89	12.02	12.16	12.
6	9.81	9.90	10.00	10.12	10.
7	8.39	8.47	8.56	8.67	8.
8	7.33	7.40	7.48	7.57	7.
10	5.85	5.90	5.96	6.03	6.
12	4.85	4.89	4.95	5.01	5.
14	4.13	4.17	4.22	4.27	4.
16	3.59	3.63	3.67	3.71	3.
18	3.17	3.20	3.24	3.28	3.
20	2.83	2.86	2.89	2.92	2.
22	2.55	2.58	2.60	2.63	2.
24	2.32	2.34	2.36	2.39	2.
26	2.11	2.13	2.16	2.18	2.
28	1.94	1.96	1.98	2.00	2.
30	1.78	1.80	1.82	1.84	1.
32	1.65	1.66	1.68	1.70	1.
34	1.53	1.54	1.56	1.58	1.
36	1.42	1.43	1.45	1.47	1.
38	1.32	1.33	1.35	1.36	1.
40	1.23	1.24	1.25	1.27	1.
42	1.14	1.15	1.17	1.18	1.
44	1.07	1.08	1.09	1.10	1.
46	1.00	1.01	1.02	1.03	1.
48	.93	.94	.95	.96	.
50	.87	.87	.88	.89	.
52	.80	.81	.82	.83	.
54	.75	.76	.76	.77	.
56	.69	.70	.71	.72	.
58	.64	.65	.66	.66	.
60	.60	.60	.61	.61	.
62	.55	.55	.56	.57	.
64	.50	.51	.51	.52	.
66	.46	.46	.47	.47	.
68	.42	.42	.42	.43	.
70	.37	.38	.38	.39	.
72	.34	.34	.34	.35	.
74	.30	.30	.30	.31	.
76	.26	.26	.26	.27	.
78	.22	.22	.22	.23	.
80	.18	.18	.18	.19	.
81	.16	.16	.17	.17	.
82	.14	.15	.15	.15	.
83	.13	.13	.13	.13	.
84	.11	.11	.11	.11	.
85	.09	.09	.09	.09	.
86	.07	.07	.07	.07	.
87	.05	.05	.05	.06	.
88	.04	.04	.04	.04	.
89	.02	.02	.02	.02	.
90	.00	.00	.00	.00	.
	14°	16°	18°	20°	22°

Corr. to Long.—Error in

TABLE 47.

Longitude Factors.

F is the change in longitude due to a change of 1′ in latitude.

Latitude.

Bearing.	30°	32°	34°	36°	38°	40°	42°	44°	Bearing.
°	′	′	′	′	′	′	′	′	°
1	66.15	67.56	69.10	70.81	72.70	74.79	77.09	79.64	1
2	33.07	33.77	34.54	35.40	36.34	37.38	38.53	39.81	2
3	22.03	22.50	23.02	23.59	24.21	24.91	25.68	26.53	3
4	16.51	16.86	17.25	17.68	18.15	18.67	19.24	19.88	4
5	13.20	13.48	13.79	14.13	14.50	14.92	15.38	15.89	5
6	10.99	11.22	11.48	11.76	12.07	12.42	12.80	13.23	6
7	9.40	9.60	9.82	10.07	10.34	10.63	10.96	11.32	7
8	8.22	8.39	8.58	8.79	9.03	9.29	9.57	9.89	8
10	6.55	6.69	6.84	7.01	7.20	7.40	7.63	7.88	10
12	5.43	5.55	5.67	5.81	5.97	6.14	6.33	6.54	12
14	4.63	4.73	4.84	4.96	5.09	5.24	5.40	5.58	14
16	4.03	4.11	4.21	4.31	4.43	4.55	4.69	4.85	16
18	3.55	3.63	3.71	3.80	3.91	4.02	4.14	4.28	18
20	3.17	3.24	3.31	3.40	3.49	3.59	3.70	3.82	20
22	2.86	2.92	2.98	3.06	3.14	3.23	3.33	3.44	22
24	2.59	2.65	2.71	2.78	2.85	2.93	3.02	3.12	24
26	2.37	2.42	2.47	2.53	2.60	2.68	2.76	2.85	26
28	2.17	2.22	2.27	2.32	2.39	2.45	2.53	2.61	28
30	2.00	2.04	2.09	2.14	2.20	2.26	2.33	2.41	30
32	1.85	1.89	1.93	1.98	2.03	2.09	2.15	2.22	32
34	1.71	1.75	1.79	1.83	1.88	1.93	1.99	2.06	34
36	1.59	1.62	1.66	1.70	1.75	1.80	1.85	1.91	36
38	1.48	1.51	1.54	1.58	1.62	1.67	1.72	1.78	38
40	1.38	1.41	1.44	1.47	1.51	1.56	1.60	1.66	40
42	1.28	1.31	1.34	1.37	1.41	1.45	1.49	1.54	42
44	1.20	1.22	1.25	1.28	1.31	1.35	1.39	1.44	44
46	1.11	1.14	1.16	1.19	1.23	1.26	1.30	1.34	46
48	1.04	1.06	1.09	1.11	1.14	1.17	1.21	1.25	48
50	.97	.99	1.01	1.04	1.06	1.09	1.13	1.17	50
52	.90	.92	.94	.97	.99	1.02	1.05	1.09	52
54	.84	.86	.88	.90	.92	.95	.98	1.01	54
56	.78	.79	.81	.83	.86	.88	.91	.94	56
58	.72	.74	.75	.77	.79	.82	.84	.87	58
60	.67	.68	.70	.71	.73	.75	.78	.80	60
62	.61	.63	.64	.66	.67	.69	.72	.74	62
64	.56	.57	.59	.60	.62	.64	.66	.68	64
66	.51	.52	.54	.55	.56	.58	.60	.62	66
68	.47	.48	.49	.50	.51	.53	.54	.56	68
70	.42	.43	.44	.45	.46	.47	.49	.51	70
72	.37	.38	.39	.40	.41	.42	.44	.45	72
74	.33	.34	.35	.35	.36	.37	.39	.40	74
76	.29	.29	.30	.31	.32	.32	.34	.35	76
78	.24	.25	.26	.26	.27	.28	.29	.29	78
80	.20	.21	.21	.22	.22	.23	.24	.24	80
81	.18	.19	.19	.20	.20	.21	.21	.22	81
82	.16	.17	.17	.17	.18	.18	.19	.19	82
83	.14	.14	.15	.15	.16	.16	.16	.17	83
84	.12	.12	.13	.13	.13	.14	.14	.15	84
85	.10	.10	.11	.11	.11	.11	.12	.12	85
86	.08	.08	.08	.09	.09	.09	.09	.10	86
87	.06	.06	.06	.06	.07	.07	.07	.07	87
88	.04	.04	.04	.04	.04	.05	.05	.05	88
89	.02	.02	.02	.02	.02	.02	.02	.02	89
90	.00	.00	.00	.00	.00	.00	.00	.00	90
	30°	32°	34°	36°	38°	40°	42°	44°	

Corr. to Long.=Error in Lat.×F.

TABLE 47.

Longitude Factor

F is the change in longitude due to a ch

Latitude.

Bearing.	46°	48°	50°	52°	54°
°	′	′	′	′	′
1	82.47	85.62	89.13	93.05	97.47
2	41.22	42.80	44.55	46.51	48.72
3	27.47	28.52	29.68	30.99	32.46
4	20.59	21.37	22.25	23.23	24.33
5	16.45	17.08	17.78	18.57	19.45
6	13.70	14.22	14.80	15.45	16.19
7	11.72	12.17	12.67	13.23	13.86
8	10.24	10.63	11.07	11.56	12.11
10	8.16	8.48	8.82	9.21	9.65
12	6.77	7.03	7.32	7.64	8.00
14	5.77	5.99	6.24	6.51	6.82
16	5.02	5.21	5.42	5.66	5.93
18	4.43	4.60	4.79	5.00	5.24
20	3.95	4.11	4.27	4.46	4.67
22	3.56	3.70	3.85	4.02	4.21
24	3.23	3.36	3.49	3.65	3.82
26	2.95	3.06	3.19	3.33	3.49
28	2.71	2.81	2.93	3.05	3.20
30	2.49	2.59	2.69	2.81	2.95
32	2.30	2.39	2.49	2.60	2.72
34	2.13	2.22	2.31	2.41	2.52
36	1.98	2.06	2.14	2.24	2.34
38	1.84	1.91	1.99	2.08	2.18
40	1.71	1.78	1.85	1.94	2.03
42	1.60	1.66	1.73	1.80	1.89
44	1.49	1.55	1.61	1.68	1.76
46	1.39	1.44	1.50	1.57	1.64
48	1.30	1.35	1.40	1.46	1.53
50	1.21	1.25	1.31	1.36	1.43
52	1.12	1.17	1.22	1.27	1.33
54	1.05	1.09	1.13	1.18	1.23
56	.97	1.01	1.05	1.10	1.15
58	.90	.93	.97	1.01	1.06
60	.83	.86	.90	.94	.98
62	.77	.79	.83	.86	.90
64	.70	.73	.76	.79	.83
66	.64	.66	.69	.72	.76
68	.58	.60	.63	.65	.69
70	.52	.54	.57	.59	.62
72	.47	.49	.51	.53	.55
74	.41	.43	.45	.46	.49
76	.36	.37	.39	.40	.42
78	.31	.32	.33	.34	.36
80	.25	.26	.27	.29	.30
81	.23	.24	.25	.26	.27
82	.20	.21	.22	.23	.24
83	.18	.18	.19	.20	.21
84	.15	.16	.16	.17	.18
85	.13	.13	.14	.14	.15
86	.10	.10	.11	.11	.12
87	.08	.08	.08	.08	.09
88	.05	.05	.05	.06	.06
89	.02	.03	.03	.03	.03
90	.00	.00	.00	.00	.00
	46°	48°	50°	52°	54°

Corr. to Long.=Error in La

TABLE 48.

Latitude Factors.

f is the change in latitude due to a change of 1′ in longitude.

Latitude.

Bearing.	0°	1°	2°	4°	6°	8°	10°	12°	Bearing.
°	′	′	′	′	′	′	′	′	°
1	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	1
2	.03	.03	.03	.03	.03	.03	.03	.03	2
3	.05	.05	.05	.05	.05	.05	.05	.05	3
4	.07	.07	.07	.07	.07	.07	.07	.07	4
5	.09	.09	.09	.09	.09	.09	.09	.09	5
6	.11	.11	.11	.10	.10	.10	.10	.10	6
7	.12	.12	.12	.12	.12	.12	.12	.12	7
8	.14	.14	.14	.14	.14	.14	.14	.14	8
10	.18	.18	.18	.18	.18	.17	.17	.17	10
12	.21	.21	.21	.21	.21	.21	.21	.21	12
14	.25	.25	.25	.25	.25	.25	.25	.24	14
16	.29	.29	.29	.29	.28	.28	.28	.28	16
18	.32	.32	.32	.32	.32	.32	.32	.32	18
20	.36	.36	.36	.36	.36	.36	.36	.36	20
22	.40	.40	.40	.40	.40	.40	.40	.40	22
24	.44	.44	.44	.44	.44	.44	.44	.43	24
26	.49	.49	.49	.49	.49	.48	.48	.48	26
28	.53	.53	.53	.53	.53	.53	.52	.52	28
30	.58	.58	.58	.57	.57	.57	.57	.56	30
32	.63	.63	.63	.63	.62	.62	.61	.61	32
34	.68	.68	.68	.67	.67	.67	.67	.66	34
36	.72	.72	.72	.72	.72	.72	.71	.71	36
38	.78	.78	.78	.78	.78	.78	.77	.76	38
40	.84	.84	.84	.84	.83	.83	.83	.82	40
42	.90	.90	.90	.90	.89	.89	.88	.88	42
44	.96	.96	.96	.96	.96	.95	.95	.94	44
46	1.04	1.04	1.04	1.03	1.03	1.03	1.02	1.01	46
48	1.11	1.11	1.11	1.11	1.11	1.10	1.10	1.09	48
50	1.19	1.19	1.19	1.19	1.19	1.18	1.17	1.17	50
52	1.28	1.28	1.28	1.28	1.27	1.27	1.26	1.25	52
54	1.38	1.38	1.38	1.37	1.37	1.36	1.36	1.35	54
56	1.48	1.48	1.48	1.48	1.47	1.47	1.46	1.45	56
58	1.60	1.60	1.60	1.60	1.59	1.58	1.58	1.57	58
60	1.73	1.73	1.73	1.73	1.72	1.72	1.71	1.69	60
62	1.88	1.88	1.88	1.88	1.87	1.86	1.85	1.84	62
64	2.05	2.05	2.05	2.05	2.04	2.03	2.02	2.01	64
66	2.25	2.25	2.24	2.24	2.23	2.22	2.21	2.20	66
68	2.48	2.48	2.47	2.47	2.46	2.45	2.44	2.42	68
70	2.75	2.75	2.75	2.74	2.73	2.72	2.71	2.69	70
72	3.08	3.08	3.08	3.07	3.06	3.05	3.03	3.01	72
74	3.49	3.49	3.49	3.48	3.47	3.45	3.43	3.41	74
76	4.01	4.01	4.01	4.00	3.99	3.97	3.95	3.92	76
78	4.70	4.70	4.70	4.69	4.68	4.66	4.63	4.60	78
80	5.67	5.67	5.67	5.66	5.64	5.62	5.59	5.55	80
81	6.31	6.31	6.31	6.30	6.28	6.25	6.22	6.18	81
82	7.12	7.11	7.11	7.10	7.07	7.05	7.01	6.96	82
83	8.15	8.14	8.14	8.13	8.10	8.07	8.02	7.97	83
84	9.52	9.51	9.51	9.49	9.46	9.42	9.37	9.31	84
85	11.43	11.43	11.42	11.40	11.37	11.32	11.25	11.18	85
86	14.30	14.30	14.29	14.27	14.22	14.16	14.08	13.99	86
87	19.08	19.08	19.07	19.03	18.98	18.91	18.79	18.66	87
88	28.63	28.63	28.62	28.57	28.48	28.35	28.20	28.01	88
89	57.29	57.28	57.26	57.15	56.98	56.73	56.42	56.04	89
	0°	1°	2°	4°	6°	8°	10°	12°	

Cor. to Lat. = Error in Long. × f.

TABLE 4

Latitude Fact

f is the change in latitude due to a c

Latitude.

Bearing.	14°	16°	18°	20°	22
°	′	′	′	′	
1	0.02	0.02	0.02	0.02	0.
2	.03	.03	.03	.03	.
3	.05	.05	.05	.05	.
4	.07	.07	.07	.07	.
5	.08	.08	.08	.08	.
6	.10	.10	.10	.10	.
7	.12	.12	.12	.12	.
8	.14	.14	.13	.13	.
10	.17	.17	.17	.17	.
12	.21	.20	.20	.20	.
14	.24	.24	.24	.23	.
16	.28	.28	.27	.27	.
18	.32	.31	.31	.30	.
20	.35	.35	.35	.34	.
22	.39	.39	.38	.38	.
24	.43	.43	.42	.42	.
26	.47	.47	.46	.46	.
28	.52	.51	.51	.50	.
30	.56	.56	.55	.54	.
32	.61	.60	.60	.59	.
34	.65	.65	.64	.63	.
36	.70	.70	.69	.68	.
38	.76	.75	.74	.74	.
40	.81	.81	.80	.79	.
42	.88	.87	.85	.85	.
44	.93	.93	.92	.91	.
46	1.01	1.00	.99	.97	.
48	1.08	1.07	1.06	1.04	1.
50	1.16	1.15	1.13	1.12	1.
52	1.24	1.23	1.22	1.20	1.
54	1.34	1.32	1.31	1.29	1.
56	1.44	1.43	1.41	1.39	1.
58	1.55	1.54	1.52	1.50	1.
60	1.68	1.67	1.65	1.63	1.
62	1.83	1.81	1.79	1.77	1.
64	1.99	1.97	1.95	1.93	1.
66	2.18	2.16	2.14	2.11	2.
68	2.40	2.38	2.35	2.33	2.
70	2.67	2.64	2.61	2.58	2.
72	2.99	2.96	2.93	2.89	2.
74	3.38	3.35	3.32	3.28	3.
76	3.89	3.86	3.81	3.77	3.
78	4.56	4.52	4.47	4.42	4.
80	5.50	5.45	5.39	5.33	5.
81	6.13	6.07	6.01	5.93	5.
82	6.90	6.84	6.77	6.69	6.
83	7.90	7.83	7.75	7.65	7.
84	9.23	9.15	9.05	8.94	8.
85	11.09	10.99	10.87	10.74	10.
86	13.88	13.75	13.60	13.44	13.
87	18.51	18.34	18.15	17.93	17.
88	27.78	27.52	27.23	26.91	26.
89	55.59	55.07	54.49	53.84	53.
	14°	16°	18°	20°	22

Corr. to Lat.=Error in

TABLE 48.

Latitude Factors.

f is the change in latitude due to a change of 1′ in longitude.

Bearing.	Latitude. 30°	32°	34°	36°	38°	40°	42°	44°	Bearing.
°	′	′	′	′	′	′	′	′	°
1	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	1
2	.03	.03	.03	.03	.03	.03	.03	.03	2
3	.05	.05	.04	.04	.04	.04	.04	.04	3
4	.06	.06	.06	.06	.06	.05	.05	.05	4
5	.08	.07	.07	.07	.07	.07	.07	.06	5
6	.09	.09	.09	.09	.08	.08	.08	.08	6
7	.11	.10	.10	.10	.10	.09	.09	.09	7
8	.12	.12	.12	.11	.11	.11	.10	.10	8
10	.15	.15	.15	.14	.14	.14	.13	.13	10
12	.18	.18	.18	.17	.17	.16	.16	.15	12
14	.22	.21	.21	.20	.20	.19	.19	.18	14
16	.25	.24	.24	.23	.23	.22	.21	.21	16
18	.28	.28	.27	.26	.26	.25	.24	.23	18
20	.32	.31	.30	.29	.29	.28	.27	.26	20
22	.35	.34	.34	.33	.32	.31	.30	.29	22
24	.39	.38	.37	.36	.35	.34	.33	.32	24
26	.42	.41	.40	.40	.38	.37	.36	.35	26
28	.46	.45	.44	.43	.42	.41	.40	.38	28
30	.50	.49	.48	.47	.45	.44	.43	.41	30
32	.54	.53	.52	.51	.49	.48	.47	.45	32
34	.58	.57	.56	.55	.53	.52	.50	.49	34
36	.63	.62	.60	.59	.57	.56	.54	.52	36
38	.68	.66	.65	.63	.62	.60	.58	.56	38
40	.72	.71	.69	.68	.66	.64	.63	.60	40
42	.78	.76	.75	.73	.71	.69	.67	.65	42
44	.83	.82	.80	.78	.76	.74	.72	.69	44
46	.90	.88	.86	.84	.82	.79	.77	.74	46
48	.96	.94	.92	.90	.88	.85	.83	.80	48
50	1.03	1.01	.99	.96	.94	.91	.88	.86	50
52	1.11	1.09	1.06	1.04	1.01	.98	.95	.92	52
54	1.19	1.16	1.14	1.11	1.08	1.05	1.02	.99	54
56	1.28	1.26	1.23	1.20	1.17	1.14	1.10	1.07	56
58	1.39	1.36	1.33	1.30	1.26	1.23	1.19	1.15	58
60	1.49	1.47	1.44	1.40	1.37	1.33	1.29	1.25	60
62	1.63	1.59	1.56	1.52	1.48	1.44	1.40	1.35	62
64	1.78	1.74	1.70	1.66	1.62	1.57	1.52	1.48	64
66	1.95	1.91	1.85	1.82	1.77	1.72	1.67	1.62	66
68	2.14	2.10	2.05	2.00	1.95	1.90	1.84	1.78	68
70	2.38	2.33	2.28	2.22	2.17	2.10	2.04	1.98	70
72	2.67	2.61	2.55	2.50	2.43	2.36	2.29	2.21	72
74	3.02	2.96	2.89	2.82	2.75	2.67	2.59	2.51	74
76	3.47	3.40	3.33	3.25	3.16	3.07	2.98	2.89	76
78	4.07	3.99	3.90	3.81	3.71	3.60	3.50	3.38	78
80	4.91	4.81	4.70	4.59	4.47	4.34	4.22	4.08	80
81	5.47	5.35	5.24	5.11	4.98	4.84	4.69	4.54	81
82	6.16	6.03	5.90	5.76	5.61	5.45	5.29	5.12	82
83	7.05	6.91	6.75	6.59	6.42	6.24	6.05	5.86	83
84	8.24	8.07	7.93	7.70	7.50	7.29	7.07	6.84	84
85	9.90	9.69	9.48	9.25	9.01	8.75	8.49	8.22	85
86	12.39	12.13	11.86	11.57	11.27	10.95	10.63	10.29	86
87	16.52	16.18	15.82	15.44	15.04	14.62	14.18	13.73	87
88	24.80	24.28	23.74	23.17	22.56	21.93	21.28	20.60	88
89	49.61	48.58	47.50	46.36	45.14	43.98	42.58	41.21	89
	30°	32°	34°	36°	38°	40°	42°	44°	

Corr. to Lat. = Error in Long. × f.

TABLE 48.

Latitude Factor

f is the change in latitude due to a char

Bearing.	Latitude. 46°	48°	50°	52°	54°
°	′	′	′	′	′
1	0.01	0.01	0.01	0.01	0.0
2	.02	.02	.02	.02	.0
3	.04	.03	.03	.03	.0
4	.05	.05	.04	.04	.0
5	.06	.06	.06	.05	.0
6	.07	.07	.07	.06	.0
7	.08	.08	.08	.08	.0
8	.10	.09	.09	.08	.0
10	.12	.12	.11	.11	.1
12	.15	.14	.14	.13	.1
14	.17	.17	.16	.15	.1
16	.20	.19	.18	.18	.1
18	.23	.22	.21	.20	.1
20	.25	.24	.23	.22	.2
22	.28	.27	.26	.25	.2
24	.31	.30	.29	.27	.2
26	.34	.33	.31	.30	.2
28	.37	.36	.34	.33	.3
30	.40	.39	.37	.36	.3
32	.43	.42	.40	.38	.3
34	.47	.45	.43	.41	.4
36	.51	.49	.47	.45	.4
38	.54	.52	.50	.48	.4
40	.58	.56	.54	.52	.4
42	.63	.60	.58	.56	.5
44	.67	.65	.62	.60	.5
46	.72	.69	.67	.64	.6
48	.77	.74	.71	.68	.6
50	.83	.80	.77	.73	.7
52	.89	.86	.82	.79	.7
54	.96	.92	.88	.85	.8
56	1.03	.99	.95	.91	.8
58	1.11	1.07	1.03	.99	.9
60	1.20	1.16	1.11	1.07	1.0
62	1.31	1.26	1.21	1.16	1.1
64	1.42	1.37	1.32	1.26	1.2
66	1.56	1.50	1.44	1.38	1.3
68	1.72	1.66	1.59	1.52	1.4
70	1.91	1.84	1.77	1.69	1.6
72	2.14	2.06	1.99	1.89	1.8
74	2.42	2.33	2.24	2.15	2.0
76	2.79	2.68	2.58	2.47	2.3
78	3.27	3.15	3.02	2.90	2.7
80	3.94	3.80	3.70	3.49	3.3
81	4.39	4.23	4.06	3.89	3.7
82	4.94	4.76	4.57	4.38	4.1
83	5.66	5.45	5.24	5.01	4.7
84	6.61	6.37	6.12	5.86	5.5
85	7.94	7.65	7.35	7.04	6.7
86	9.94	9.57	9.19	8.81	8.4
87	13.26	12.77	12.27	11.75	11.2
88	19.89	19.16	18.41	17.64	16.8
89	39.80	38.34	36.83	35.24	33.6
	46°	48°	50°	52°	54°

Corr. to Lat.—Error in

TABLE 49.

Corrections for the Observed Altitudes of the Moon's Lower Limb.

Obs. Alt. Lower Limb.	HORIZONTAL PARALLAX.							
	54′	55′	56′	57′	58′	59′	60′	61′
° ′	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″
5 30	53 46	55 03	56 19	57 36	58 53	60 09	61 27	62 44
6 00 ADD	54 22	55 38	56 54	58 11	59 28	60 44	62 01	63 18
6 30	54 51	56 08	57 24	58 40	59 57	61 13	62 29	63 46
7 00	55 17	56 33	57 50	59 06	60 22	61 38	62 54	64 11
7 30	55 39	56 55	58 12	59 28	60 44	62 00	63 16	64 33
8 00	55 58	57 15	58 31	59 47	61 03	62 19	63 36	64 52
8 30	56 15	57 31	58 47	60 03	61 19	62 35	63 52	65 08
9 00	56 29	57 45	59 01	60 16	61 33	62 49	64 05	65 20
9 30	56 42	57 58	59 13	60 29	61 45	63 01	64 17	65 32
10 00	56 54	58 10	59 25	60 40	61 56	63 11	64 27	65 42
11	57 10	58 26	59 41	60 56	62 12	63 27	64 43	65 58
12	57 22	58 37	59 52	61 07	62 23	63 39	64 54	66 09
13	57 29	58 45	59 59	61 14	62 30	63 45	65 00	66 15
14	57 35	58 50	60 04	61 18	62 33	63 48	65 03	66 17
15	57 35	58 50	60 04	61 18	62 33	63 48	65 03	66 17
16	57 33	58 47	60 01	61 15	62 30	63 45	64 59	66 13
17	57 30	58 44	59 57	61 11	62 26	63 39	64 53	66 07
18	57 23	58 36	59 49	61 03	62 17	63 31	64 45	65 59
19	57 15	58 28	59 41	60 54	62 08	63 21	64 35	65 49
20	57 05	58 18	59 31	60 44	61 57	63 10	64 23	65 36
21	56 53	58 06	59 18	60 31	61 44	62 56	64 09	65 22
22	56 40	57 52	59 03	60 15	61 28	62 40	63 53	65 06
23	56 25	57 38	58 49	60 00	61 12	62 24	63 36	64 48
24	56 09	57 20	58 31	59 42	60 54	62 06	63 18	64 28
25	55 51	57 02	58 13	59 24	60 36	61 47	62 58	64 08
26	55 32	56 43	57 53	59 03	60 14	61 25	62 36	63 46
27	55 12	56 22	57 32	58 41	59 51	61 01	62 12	63 22
28	54 51	56 00	57 09	58 18	59 28	60 38	61 48	62 57
29	54 28	55 37	56 46	57 55	59 05	60 14	61 23	62 33
30	54 04	55 13	56 21	57 29	58 38	59 47	60 56	62 05
31	53 39	54 47	55 55	57 03	58 12	59 20	60 28	61 36
32	53 14	54 22	55 29	56 36	57 44	58 52	60 00	61 07
33	52 47	53 54	55 01	56 08	57 15	58 22	59 29	60 36
34	52 20	53 26	54 31	55 37	56 44	57 50	58 57	60 03
35	51 51	52 56	54 01	55 06	56 12	57 18	58 24	59 30
36	51 21	52 26	53 30	54 35	55 41	56 46	57 51	58 55
37	50 51	51 54	52 57	54 02	55 07	56 12	57 17	58 22
38	50 19	51 23	52 26	53 30	54 33	55 37	56 41	57 45
39	49 47	50 50	51 52	52 55	53 58	55 02	56 05	57 08
40	49 13	50 15	51 16	52 18	53 21	54 24	55 27	56 29
41	48 38	49 40	50 41	51 43	52 45	53 47	54 49	55 50
42	48 03	49 04	50 04	51 06	52 07	53 09	54 11	55 12
43	47 28	48 28	49 28	50 28	51 30	52 30	53 30	54 30
44	46 51	47 51	48 49	49 49	50 49	51 48	52 48	53 47
45	46 13	47 12	48 10	49 09	50 09	51 08	52 07	53 06
46	45 35	46 33	47 30	48 28	49 27	50 26	51 24	52 22
47	44 55	45 53	46 50	47 48	48 46	49 43	50 41	51 38
48	44 15	45 13	46 09	47 06	48 03	48 59	49 56	50 52
49	43 36	44 32	45 27	46 23	47 19	48 15	49 11	50 06
50	42 54	43 50	44 44	45 39	46 34	47 30	48 25	49 20
51	42 12	43 07	44 01	44 55	45 50	46 44	47 38	48 32
52	41 30	42 23	43 16	44 09	45 04	45 57	46 51	47 44
53	40 46	41 39	42 31	43 24	44 17	45 09	46 02	46 54
54	40 02	40 54	41 45	42 37	43 30	44 21	45 13	46 04
55	39 17	40 09	40 59	41 50	42 42	43 32	44 23	45 14
56	38 33	39 23	40 13	41 02	41 53	42 44	43 34	44 24
57	37 47	38 37	39 26	40 14	41 04	41 53	42 43	43 32
58	37 01	37 50	38 38	39 25	40 14	41 03	41 52	42 39
59	36 15	37 03	37 49	38 36	39 24	40 11	40 59	41 46
60	35 28	36 15	37 00	37 46	38 34	39 20	40 06	40 52
61	34 39	35 25	36 10	36 56	37 42	38 27	39 13	39 58
62	33 50	34 35	35 19	36 04	36 49	37 34	38 19	39 03
63	33 02	33 46	34 29	35 13	35 57	36 41	37 25	38 08

TABLE 49.

Corrections for the Observed Altitudes o

Obs. Alt. Lower Limb.	HORIZONTAL P			
	54′	55′	56′	57′
° ′	′ ″	′ ″	′ ″	′ ″
64	32 13	32 56	33 38	34 21
65	31 23	32 06	32 47	33 28
66	30 33	31 14	31 54	32 35
67	29 42	30 22	31 01	31 41
68	28 51	29 31	30 09	30 47
69	27 59	28 38	29 15	29 53
70	27 07	27 46	28 22	28 59
71	26 15	26 52	27 27	28 04
72	25 23	25 58	26 32	27 08
73	24 30	25 05	25 38	26 12
74	23 37	24 11	24 42	25 16
75	22 44	23 16	23 47	24 19
76	21 51	22 22	22 52	23 23
77	20 57	21 27	21 56	22 26
78	20 02	20 32	21 00	21 30
79	19 08	19 36	20 04	20 31
80	18 13	18 41	19 07	19 33
81	17 19	17 45	18 10	18 35
82	16 24	16 49	17 13	17 37
83	15 29	15 53	16 16	16 40
84	14 33	14 57	15 19	15 42
85	13 38	14 00	14 21	14 43
86	12 43	13 04	13 24	13 45
87	11 47	12 08	12 26	12 46
88	10 52	11 11	11 28	11 47
89	9 56	10 15	10 31	10 48
90	9 00	9 18	9 34	9 50

Height of Eye Corre	
Height in feet.	Corr
10	+
12	+
14	+
16	+
18	+
20	+
22	+
24	+
26	+
28	+
30	+
35	
40	−
45	−
50	−
55	−
60	−
65	−
70	−
75	−
80	−
85	−
90	−
95	−
100	−

TABLE 49.

Corrections for the Observed Altitude of the Moon's Upper Limb.

Obs. Alt. Upper Limb.	HORIZONTAL PARALLAX.							
	54′	55′	56′	57′	58′	59′	60′	61′
° ′	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″
5 30	23 38	24 21	25 05	25 48	26 31	27 13	27 56	28 38
6 00 ADD	24 18	25 01	25 44	26 27	27 10	27 54	28 37	29 19
6 30	24 52	25 35	26 18	27 02	27 44	28 28	29 11	29 54
7 00	25 21	26 04	26 48	27 31	28 13	28 57	29 40	30 24
7 30	25 47	26 30	27 13	27 56	28 39	29 22	30 05	30 48
8 00	26 09	26 52	27 35	28 18	29 01	29 44	30 27	31 09
8 30	26 28	27 11	27 54	28 37	29 20	30 03	30 46	31 28
9 00	26 45	27 27	28 10	28 53	29 36	30 19	31 02	31 44
9 30	27 00	27 42	28 24	29 06	29 49	30 32	31 15	31 57
10 00	27 10	27 53	28 36	29 19	30 01	30 44	31 27	32 09
11	27 31	28 13	28 55	29 38	30 21	31 03	31 46	32 28
12	27 45	28 27	29 10	29 52	30 34	31 16	31 58	32 40
13	27 54	28 36	29 18	30 00	30 42	31 24	32 07	32 49
14	27 59	28 40	29 22	30 05	30 47	31 29	32 11	32 52
15	28 01	28 42	29 24	30 06	30 48	31 30	32 11	32 53
16	28 01	28 42	29 23	30 04	30 45	31 27	32 09	32 50
17	27 58	28 39	29 20	30 01	30 42	31 23	32 04	32 45
18	27 51	28 32	29 13	29 54	30 34	31 15	31 55	32 35
19	27 44	28 24	29 05	29 45	30 26	31 06	31 46	32 26
20	27 34	28 13	28 54	29 34	30 14	30 54	31 34	32 15
21	27 23	28 03	28 43	29 23	30 02	30 41	31 21	32 01
22	27 10	27 49	28 29	29 08	29 47	30 27	31 06	31 45
23	26 55	27 33	28 12	28 52	29 30	30 09	30 49	31 27
24	26 39	27 17	27 56	28 35	29 13	29 52	30 31	31 10
25	26 22	27 00	27 38	28 17	28 55	29 33	30 11	30 48
26	26 03	26 40	27 18	27 56	28 34	29 12	29 49	30 26
27	25 43	26 20	26 58	27 36	28 12	28 49	29 26	30 03
28	25 21	25 58	26 35	27 12	27 48	28 25	29 03	29 39
29	24 59	25 35	26 12	26 48	27 24	28 01	28 37	29 12
30	24 36	25 11	25 47	26 24	26 59	27 35	28 10	28 46
31	24 12	24 47	25 22	25 57	26 32	27 07	27 43	28 18
32	23 45	24 20	24 55	25 30	26 04	26 39	27 14	27 48
33	23 19	23 53	24 27	25 01	25 35	26 09	26 43	27 17
34	22 51	23 24	23 58	24 32	25 06	25 39	26 12	26 45
35	22 22	22 55	23 28	24 01	24 34	25 07	25 40	26 12
36	21 53	22 25	22 58	23 30	24 03	24 34	25 07	25 39
37	21 23	21 54	22 26	22 58	23 29	24 00	24 31	25 03
38	20 51	21 22	21 53	22 24	22 54	23 25	23 56	24 28
39	20 19	20 49	21 20	21 50	22 20	22 50	23 20	23 50
40	19 46	20 15	20 45	21 15	21 45	22 14	22 43	23 12
41	19 11	19 40	20 09	20 38	21 06	21 35	22 04	22 33
42	18 37	19 05	19 33	20 01	20 29	20 57	21 25	21 54
43	18 00	18 27	18 55	19 23	19 50	20 18	20 45	21 13
44	17 24	17 50	18 17	18 45	19 11	19 37	20 04	20 32
45	16 46	17 12	17 38	18 04	18 30	18 56	19 22	19 48
46	16 07	16 33	16 58	17 24	17 49	18 14	18 40	19 05
47	15 28	15 53	16 18	16 43	17 07	17 32	17 57	18 21
48	14 48	15 12	15 36	16 00	16 24	16 48	17 12	17 36
49	14 07	14 31	14 55	15 17	15 40	16 04	16 27	16 50
50	13 26	13 49	14 11	14 34	14 56	15 19	15 41	16 03
51	12 44	13 06	13 27	13 49	14 10	14 32	14 54	15 15
52	12 02	12 23	12 44	13 05	13 25	13 46	14 07	14 27
53	11 19	11 39	11 59	12 19	12 38	12 59	13 19	13 38
54	10 36	10 54	11 13	11 32	11 51	12 11	12 30	12 49
55	9 51	10 09	10 27	10 45	11 03	11 23	11 41	11 59
56	9 06	9 23	9 40	9 58	10 15	10 32	10 49	11 06
57	8 21	8 37	8 53	9 10	9 26	9 43	9 59	10 15
58	7 35	7 50	8 05	8 21	8 36	8 52	9 07	9 22
59	6 48	7 02	7 17	7 32	7 46	8 01	8 16	8 30
60	6 00	6 13	6 27	6 41	6 55	7 09	7 23	7 36
61	5 12	5 24	5 37	5 50	6 04	6 17	6 29	6 42
62	4 23	4 35	4 48	5 00	5 12	5 23	5 35	5 46
63	3 35	3 46	3 57	4 08	4 19	4 30	4 40	4 51

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